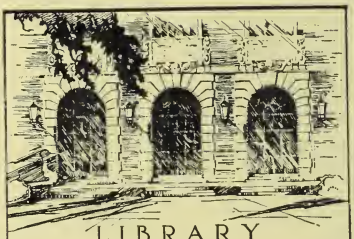
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NEW SOUTH WALES.

DEPARTMENT OF MINES AND AGRICULTURE.

GEOLOGICAL SURVEY.

MINERAL RESOURCES.

No. 12.

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REPORT

ON THE

DRAKE GOLD AND COPPER FIELD.

BY

E. C. ANDREWS, B.A.,

GEOLOGICAL SURVEYOR.

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INTRODUCTION.

Acting under instructions from Mr. E. F. Pittman, Government Geologist and Under Secretary for Mines, a geological survey of the Drake Mining Field was made by me during the spring of 1904. On the trip I was accompanied by Mr. M. Morrison, Senior Field Assistant.

It is a difficult area to map accurately, *i.e.*, in which to supply a connected sequence of geological events. Instead of containing several strong lines of rock junctions, whose succession in time might thus be readily grasped, it consists of a mass of insignificant and overlapping lava flows, sandwiched in with which are certain fossil beds. Dense jungle growths are common, which still further complicate mapping work.

Several of the lava outcrops in this rough country were mapped in by Mr. Morrison, during my temporary absence in New England.

Drake, at present, is a very neglected field, a fact due, in great measure, to its complicated and minute structures.

I am greatly indebted to Mr. J. P. Curran, J.P., Mining Registrar of Drake, who from his great local knowledge has supplied me with the historical notes of the field. These notes have been adopted almost word for word in the chapter on the history of Drake. The Notes on the Boorook and Lunatic Reefs have been also supplied by Mr. Curran.

To Mr. L. Gundlach, L.S., my best thanks also are due for notes on the White Rock ore and metallurgical processes, also for details of the Adeline property.

I desire, also, to record my thanks to Mr. D. Cullen, Mr. Edgar Hall, Mr. Thos. Horton, Mr. J. P. Curran, Mr. Arthur Smith, Mr. Clarence Smith, and Mr. J. Thomas (Rivertree), for pointing out to me the various fossil beds of the Drake district. Mention of these fossil finds will be made in their proper place in the chapter on the general geology of the field.

The Permo-Carboniferous age of the strata described in the report was determined by Mr. W. S. Dun, Palæontologist to the Survey.

The maps and sections were prepared by Mr. O. Trickett, L.S.

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REPORT

ON THE

DRAKE GOLD AND COPPER FIELD.

History of the Field.*

In 1878 silver was discovered at Boorook by the late Mr. Thomas Horton, in the Golden Age Mine, which was, possibly, the first deposit of silver ore worked at a profit in New South Wales.

Mr. Horton, for about three years, endeavoured to extract the metal from the ore with very primitive appliances only, and was partially successful whilst operating on the oxidised belt of mineral which extended to a depth of 80 feet from the surface. Below that depth, however, when the sulphides came in, chlorination furnaces were erected. At this juncture Mr. Wesley Hall purchased the mine, and with the assistance of Mr. Benjamin Davey, an experienced metallurgist, erected furnaces and other machinery for the proper saving of the metal. Successful extraction was thus carried on for a further period of three years.

The main shaft on the mine was sunk to a depth of 320 feet. At the 150-feet level a large bunch of sulphide ore was met with. This in its widest part was 19 feet, and averaged 40 oz. of silver per ton.

In 1886 the Adeline Mine, at Drake, was discovered by one named Costa, who, *en route* to Casino, camped near the site of the present Adeline workings. Noticing some peculiar appearance in the rock on the side of a neighbouring slight rise, a miner's curiosity induced him to examine the stone, which outwardly resembled specimens he had seen at Mount Morgan. On crushing the sample he found unmistakable indications of a valuable deposit of gold. Further search enabled him to locate the Adeline Reef. This mine has since been worked with varying success. Both gold and copper are won from this property.

The discovery of the Adeline gold gave a great local impetus to prospecting, and the precious metal was rapidly discovered in various places on Mount Carrington, known formerly as Mount Pleasant.

The Mount Carrington Mine, situated on the crown of the mountain, was the first to come into prominence. It passed out of the hands of the original prospectors, and has since produced a large quantity of gold.

The Pioneer Mine was one of the most important lines of reef on this hill. It has furnished employment to a large number of miners, and has also yielded important gold and copper values.

The All Nations Mine was also discovered during this prospecting campaign. It occurs on the northern side of the hill (Carrington). on the slope into Sawpit Gully. For several years it yielded fair quantities of gold, while mining operations were confined to the oxidised belt.

* Being notes supplied by Mr. J. P. Currant J.P.

The Lady Mary is another mine, on the northern slope of Mount Carrington, which has yielded a considerable quantity of gold and copper.

Lower down Sawpit Gully a large formation containing gold and silver in small quantities was held by the Sawpit Gully Gold and Silver Mining Company. For the purpose of working this low-grade ore reduction works, costing several thousands of pounds, were erected. The ore treated was reported to be worth 26s. per ton, from a lode 33 feet wide at the 100-feet level. The treatment was, however, unsuccessful.

Following on the discovery of gold in the localities mentioned, prospecting operations were extended to more outlying areas. Red Rock, 10 or 12 miles from Drake, in a north-westerly direction, was thus discovered. The lodes in this locality are numerous, but their gold values are poor—9 dwt. to the ton being about the highest known yield. In the Red Rock Company's mine a large deposit of zinc was met with at the 100-feet level.

The ore (zinc) is of fair quality, and can be concentrated up to 60 per cent. metal.

The White Rock Silver-mine was the next discovery in the same year, (1886) by Mr. Rossiter and Mr. T. Horton. For a time it was thought by many that its fame would eclipse that of Broken Hill.

To the south of Drake the Mascotte Mine was discovered soon after the finding of the Adeline by Costa. A rich bunch of sulphide ore was passed through from the surface to a depth of 60 feet. Sinking was then carried to a depth of 200 feet, but nothing of value was encountered.

Several parties have worked this mine from time to time. The ores won contain both gold and silver values.

Seven miles south of Drake one comes on the Lady Jersey Mine. This is a peculiar formation and cannot be said to be a defined lode,* but is rather a series of pockets of zinc blende mixed with quartz containing gold. In the majority of instances the larger bunches of zinc yielded the best gold values. During the past fifteen years this mine has yielded gold of the value of £59,612.

The value of gold and other minerals (silver, copper, lead, and zinc) produced in the Drake district from 1887 to date amounts to £250,000.

Physical Geography.

Drake lies on the coastal fall of New England, and is distant 511 miles from Sydney, *viâ* Tenterfield. It is distant 73 miles by road from Lismore, and 33 miles from Tenterfield. The altitude is about 1,650 feet above sea-level, and 1,200 feet below the plateau town. The road connecting the town with the table-land is good, but hilly owing to the presence of several intervening north and south subsequent valleys. The track winds round one of the magnificent gorges, cut by the Cataract River, which, for a considerable distance, has its channel confined to the line of granite and slate junction occurring at this point. The side of the gorge opposite to that in which the road is cut is about 1,700 feet above the channel base, and is crowned in one place with a magnificent and, up till the present, inaccessible granite tor. In former times the granite forming the plateau was much higher than at present, and the present grand block represented a hard kernel from which the softer rock had been removed long since by stream action.

* The shafts are at present full of water, but the occurrence appears to be a replacement of country by ore and gangue from an insignificant fissure.—(E.C.A.).

Drake itself, as seen from the main road, does not present a rough topography to the casual traveller. The country to the south of White Rock, however, rises to a height of 1,700 feet above the town, and is intersected by a network of deep ravines, whose precipitous sides are covered with magnificent forest—tall softwood jungle (" brush "), and dense undergrowths of ferns and vines. Blue gums (*Eucalyptus saligna*) attain altitudes of 250 feet, while red mahoganies (*E. resinifera*), scrub boxes (*Tristania conferta*), and blackbutt (*E. Andrewsi*) reach heights ranging between 150 and 200 feet. Cedar-log, Plumbago, and Bullock Creeks also contain patches of magnificent softwood " brush."

On the remainder of the area forests of tallow-wood, white and red stringybark, red and grey ironbark, grey and yellow box, red gum, grey gum, spotted gum, white mahogany, and forest oak abound. From these a plentiful supply of wood for mining and furnace purposes is procurable.

The rainfall is about 40 inches.

The summer heat is rather oppressive, the thermometer at times exceeding 110° Fah. in the shade. The winters, however, are mild, 10° of frost being exceptional.

The question of the evolution of the topographic forms around Drake will be considered briefly under the head of geology.

General Geology.

The results of the Indian, South African, and Australian geological surveys reveal the existence of great geographical changes during the Permo-Carboniferous period. Professor David* has worked out the details of the Permo-Carboniferous history as recorded in the Maitland rocks of New South Wales. Two great periods of marine sedimentation are indicated for this district, each alternating with an important set of Coal Measures. Lower and Upper Marines are the names given to these marine sediments, and they total some 10,800 feet in thickness. Each was accompanied by a great Ice age. Doubtless great elevations allowed of these enormous accumulations of marine strata, and they also may be in great measure responsible for the glacial or floating ice masses.

Post-Palæozoic movement in the Maitland district has been confined to vertical movements, to block faulting, and to local igneous intrusions.

A study of the Drake area, several hundreds of miles north of Maitland, shows an equally interesting set of geographical conditions during the same period. After the deposition of the Marines and the Coal Measures, tangential thrusts brought about a mountain-making period. Repeated plutonic intrusions resulted from this folding; decreasing basicity characterising the granite massifs. The igneous cycle closed with the intrusion of numerous basic dykes, and these are associated with the main gold, copper, and silver deposits of New England.

To explain these points more clearly, the narrative style will be followed in describing the Drake geology.

In the year 1900 the Writer was shown a small patch of fossil slate by Mr. D. Cullen, of Undercliff Station. The occurrence was about a mile from the head station. The slate was intensely indurated (silicified) by reason of the net-

* *David, T. W. Edgeworth:* The Geology of the Hunter River Coal Measures. Memoirs, Geological Survey of New South Wales,—Geology, No. 4.

work of granite veins traversing it. The fossils collected during that visit have been pronounced to be Permo-Carboniferous by Mr. W. S. Dun, Palæontologist to the Survey.

The following list embraces the fossil types collected at Undercliff :—

Deltopecten illawarrensis, Morris.
Productus subquadratus (?).
Spirifera, sp. ind.
Martiniopsis subradiata.
Strophalosia Jukesi.
Protoretepora.

Here, then, at Undercliff, it appeared that the granites considerably postdated one phase of later Permo-Carboniferous sedimentation.

Mr. E. F. Pittman, Government Geologist of this State, had, however, at a much earlier period discovered the intrusion of Permo-Carboniferous Coal Measures by granite along the north-western slopes of New England. The following extract from his report of 1896* may be quoted in this connection:—

" The Ashford Coal Measures are bounded on the west (along the greater part of their length) by a belt of intrusive granite, and this feature is of special interest, because the preponderance of the evidence appears to me to indicate that the intrusion occurred after the deposition of the Permo-Carboniferous Coal Measures.

" The coal bears evidence of having been considerably altered. The lowest portion of the seam has a highly lustrous anthracitic appearance. . . . . Moreover, the upper portions of the seam present a dull semi-coked appearance. . . . . It is, of course, possible that the intrusion of the granite may have occurred prior to the deposition of the Coal Measures, and that the inclined position of the latter may be due to a fault along the eastern side of the granite. This supposition, however, would not account for the alteration in the character of the coal, and I am, therefore, inclined to think that the former hypothesis is the more correct one."†

Shortly afterwards a visit was paid to the Undercliff graphite deposits. These were found to be merely a series of dirty coal-seams associated with sandstones and slaty sandstones, the coal having been changed to graphite‡ by the action of an associated coarse granite. The strata were dipping at an angle of about 45°., and were simply surrounded and intruded in all directions by a granite similar to that which had been seen traversing the Undercliff Permo-Carboniferous slates.

The graphite beds appeared to belong to the same series as the fossiliferous strata of Undercliff§, being separated therefrom by a continuous belt of coarse acid granite, some four or five miles in width.

This granite also, during these observations, was seen to possess an extensive horizontal range, inasmuch as it formed large plateaus around Boorook,

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* Records Geol. Survey New South Wales, 1896–98, V, pp. 26–30.
The observations herein set forth by Mr. Pittman came under the writer's notice only after the preparation of the Drake report; otherwise attention would have been directed to them in previous papers dealing with the granite intrusions of New England, *e.g.* :—
Records Geol. Survey New South Wales—
Tertiary History of New England. 1903. Vol. VII, pp. 194, 195.
The Geology of the New England Plateau. Pt. I, 1904. Physiography, pp. 298, 299.
Do do do do Pt. II, do pp.
Do do do do Pt. III, do pp.

† Prof. T. W. E. David also discusses the probable intrusion of the Ashford coal (Permo-Carboniferous) seam by granite, but owing to the lack of definite criteria of intrusion, he suggests faulting of earlier granites against the Permo-Carboniferous as a probable explanation of the occurrence. (Presidential addresses, Procs. Linn. Soc. N. S. Wales, 1893, also plate.)

‡ E. C. Andrews, Ann. Rept. Dept. Mines for 1901. p. 170.

§ By an oversight in the above-mentioned report, the word *Carboniferous* was employed instead of *Permo-Carboniferous.*

Boonoo Boonoo and Wilson's Downfall. Its great extent, and the fact that it had intruded the Permo-Carboniferous slate *after folding* had taken place (the lines of folding being cut clean across), now indicated that a great period of mountain-making had closed the Permo-Carboniferous sedimentation, and that one *at least* of the typical New England granites had made its appearance during the closing phases of this mountain-making movement.

Early in 1901, when visiting New Koreelah*, *via* Acacia Creek, and also when passing through Marylands and Cherry-tree Hill Railway Stations (Queensland), opportunity was afforded of seeing Mesozoic sandstones and conglomerates, also strata most probably referable to our "chocolate shales," reposing *on old granite surfaces*. This granite was afterwards seen to be continuous with the Undercliff variety under discussion.

The area of these rocks could as yet only be faintly hinted at. To the east and north-east, along the Tweed and Richmond Rivers, as also still farther south along the Clarence, Bellinger, Nambucca, and Lower Macleay, lay a marvellously crumpled† Palæozoic complex. To the north, between Marylands, Warwick, and the New South Wales border, lay other and similar masses. Owing to the great covering of Mesozoic conglomerates and sandstones, as also the Tertiary basalts, pitchstones, and other products of volcanism—all horizontally bedded,—the meeting ground of the two Palæozoic divisions could not be located.

Again, to the north and north-west, lay a belt of granites, varying in character, whose relative ages had not yet been ascertained. Huge masses of felsites, felspar-porphyries, and "blue granites," also abounded here. To the more immediate south lay the slates and felsites of Drake, still not correlated, while east and north-east of Drake were great masses of folded slates. At Drake the strata had been thrown into gentle folds only, while those some miles east possessed an almost vertical inclination.

In 1902, while at Drake, the Writer met Mr. Edgar Hall,‡ and through his kindness was enabled to secure a collection of Permo-Carboniferous fossils from the locality.

The following is a list of the fossil types secured on that occasion:—

Martiniopsis subradiata var. *deltoidea*, Eth. fil.
Fenestella.
Strophalosia Jukesii, Eth. fil.
Productus (*undatus* ?).
Spirifera Stokesi, Konig.
Zaphrentis.
Stenopora (dendroid form).
Trachypora Wilkinsoni, Eth. fil.
Encrinite stems and plate impressions.
Hyalostelia (cast of spicules).
Entolium.
Modiola.
Aviculopecten (new species).
Orthoceras.

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* Thirty miles north of Undercliff.

† The shore-line between Port Macquarie and Trial Bay furnishes magnificent studies in this rock contortion.

‡ In 1899 Mr. Edgar Hall had shown the Drake fossil area to Mr. J. A. Watt, formerly of the New South Wales Geological Survey. The specimens forwarded by him to this Department had been, at that time, pronounced Permo-Carboniferous by Mr. W. S. Dun.

Next, at Rivertree, Permo-Carboniferous fossils were obtained in folded slates. About this time large fossiliferous areas in folded slates were examined at Rivertree (Cullen's Creek). Associated with them were limestone and conglomerate deposits.

The following is the fossil (Permo-Carboniferous) list:—

Spirifera, n. sp.
Fenestella fossula, Lonsd.
„ *internata*, Lonsd.
Crinoid stems.
Pleurophorus.
Trachypora (?).
Spirifera vespertilio, G. B. Sby.

An extremely interesting observation was here made. The coarse granite observed at Undercliff extended to Rivertree, and, in this locality, also intruded the Permo-Carboniferous slates. It in turn, however, cut across a dark plutonic granite, heavily charged with biotite flakes. The latter rock also intruded the Permo-Carboniferous slates. Both of these were penetrated by other granitic types, as also by still later and large eurite dykes. Last of all in this order came a series of *dioritic* dykes, accompanied by well-defined silver veins of great length. This pointed conclusively to the fact that some of our northern New England granites were referable to extremely-late or even post Permo-Carboniferous age, and also that many of the New England mineral fields might require placing in the early Mesozoic period.* The granites themselves appear to be merely expressions of relief of pressure by the mountain making, and the dioritic dykes and later introduction of mineral deposits point to the closing stages of the great granite period.

The following fossils, of Permo-Carboniferous types, were secured on the occasion of a later visit to Boorook:—

Trachypora Wilkinsoni, Eth. fil.
Crinoid stems.
Fenestella fossula, Lonsd.
„ *internata*, Lonsd.
Stenopora.
Productus (? *subquadratus*).
Strophalosia.
Martiniopsis subradiata, G. B. Sby.
Aviculopecten (2 sps., both new).

The presence, in great abundance, of *Trachypora Wilkinsoni* is interesting as indicating probably the late Permo-Carboniferous age of these beds. The slates and tuffaceous rocks are gently folded and intruded to the immediate west by a great coarse acid massif. In this locality huge masses of spherulitic rhyolites underlay the slates. One of the sheets, by reason of its superior resistance to the influences of stream-cutting and weathering, has given rise to the " Boorook Falls ; " thence, following the Cataract River for miles downstream, the banks of the stream are seen to consist of high and almost impassable slopes of felsite breccias and lavas. Along the main road from Boorook to Drake the cuttings are mainly in the folded fossiliferous slates

* The Mesozoic, as we see it, sitting on the granite surfaces points to an advanced stage in Mesozoic denudation, for it (the Mesozoic) was initiated by the Permo-Carboniferous folding, and the wearing down of the mountain ranges so as to form a granite plain at sea-level must have occupied a long period of time.

and tuffs, but along the lower "bridle track," connecting the two places, the scouring action of the Cataract, Crooked, Slaty, and Girard's Creeks, has exposed the underlying felsites* and breccias leaving the slates as huge cappings to the volcanics in the interstream areas.

During the next two years other patches of fossils were obtained at various times in the Drake district.

The following are the fossil types of Crooked Creek ;—

Internal and external casts of—

Stenopora (small dendroid form).
Fenestella fossula, Lonsd.
,, *internata*, Lonsd.
,, (? sp.).
Protoretepora (n. sp.).
Penniretepora grandis, McCoy, (De Koninck).
Crinoid stems.
Hyalostelia.
Productus subquadratus, Morris.
Martiniopsis subradiata, Sby.
Spirifer vespertilio, G. Sby.
Aviculopecten squamuliferus, Morris.
,, *elongatus*, McCoy, De Kon.
Stutchburia compressa, Morris (?).
Permo-Carboniferous. (? Lower Marine or amalgamation of Lower and Upper Marine, W. S. Dun.)

Fossils collected from Jump-up Hill, some 12 miles east of Drake township :—

Strophalosia, sp. ind.
Productus subquadratus, Morris.
†*Spirifera*, cf. *lata*, McCoy.
,, sp. nov.
,, *cf. Strzeleckii*, Morris.
† *Reticularia, cf. lineata*, Martin.
†Fenestellidæ.
Aviculopecten, cf. Mitchelli, Eth. fil. and Dun.

The fossiliferous slates at Drake had been observed to be gently folded only. Towards Jump-up, however, the strata possessed a vertical dip ; thence to Pretty Gully the dip fell to 40°.

Thus a tangential thrust from the east was suggested, unless the Drake rocks proper should be decidedly younger than the Pretty Gully series.

Shortly afterwards observations proved the Drake slates and tuffs to be younger than the associated volcanics. The latter are referable to two distinct periods—an older consisting mainly of rhyolites, and a younger mainly of andesites.

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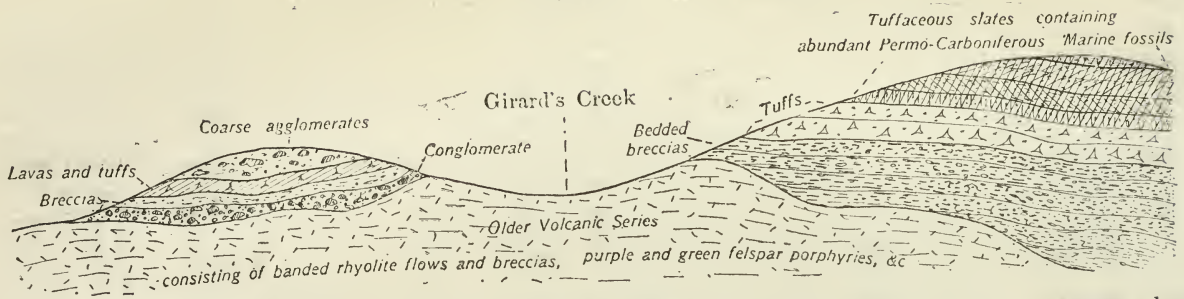
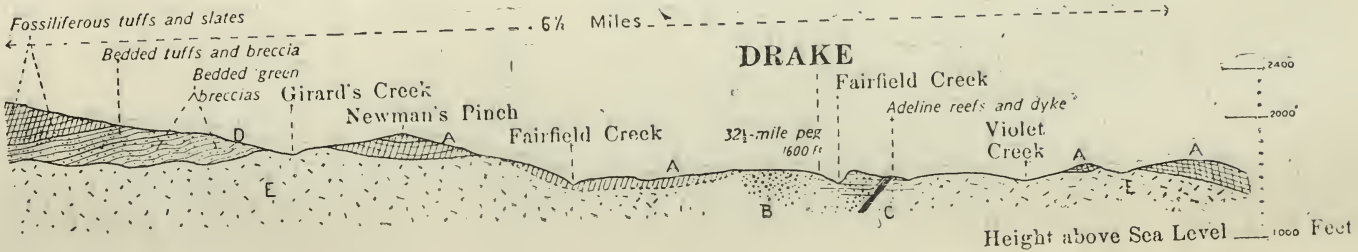
* These Boorook rhyolites were first shown to the Author in 1902, by Mr. Edgar Hall. During this visit the Author discovered the relations in time of the felsites and slates.
† Carboniferous type.

Fig. 1 (a).



Sketch section across country in vicinity of White Rock (outside of mapped area), illustrating relation of older and newer volcanics.

Fig. 1 (b).



Sketch section along Drake-road, showing relation between the older and newer volcanics.

A, Stratified tuffs and breccias with associated agglomerates and lava flows.
B, Older rhyolitic rocks.
C, Older rhyolite breccias, apparently horizontal.
D, Bedded breccias passing upwards into fossiliferous tuffs and slates.
E, Older purple and green porphyry flows, breccias, and agglomerates.

Thus the whole, felsites and slates, were shown to belong to the one great period of sedimentation.*

In June, 1903, when visiting Malarra, a coarse sphene-hornblendic granite, containing magnificent pink felspar crystals, was observed intruding the Drake felsites and bedded tuffs. Near Malarra and Timbarra this granite is in turn intruded by coarse acid granites, similar to the massif of Rivertree and Undercliff.

This rock† has a great development near Bolivia, Tenterfield, the 15-mile peg along the Tenterfield-Drake road, Wilson's Downfall, and Wallangarra, and in those localities has been intruded by the various typical fine and coarse sandy granites of New England. Moreover, this sphene-bearing granite has cut through the "blue granite" of Tenterfield, Wallangarra, and Black Swamp, while the latter in turn has intruded the Tenterfield and Deepwater felsites.

The great granite massifs had now been correlated, both with the Permo-Carboniferous strata and with each other. Some were ascertained to be valuable, and others valueless from a mining standpoint. Thus the "blue granite" and the remarkable sphene-hornblendic granite porphyry did not themselves contain metalliferous deposits of commercial value, but they had been intruded by numerous sandy granites, eurites, and pegmatites carrying tin,‡ also by still later diorite and allied dykes associated with gold, silver, lead, copper, and zinc veins.§

The fertile "blue granite" (dacite) of Tenterfield, Wellington Vale, Deepwater, and Tent Hill, which now, by reason of its relative weakness to erosive forces, occupies the valleys between the hills of younger but more resistant tin granites, was possibly of the nature of a large laccolith—that is, it had probably forced its way through and among the felsites, altered andesites, and other rock types forming northern and central New England.

The numerous high steep spurs radiating out from the head of Girard's Creek were capped with slates, while felsites were invariably met with on tracing the rocks either down the points of the spurs or along the channels of the ravine watercourses. In all a decided thickening of slates was observed to the west and north. The great scouring action of the Cataract River and its tributaries reveals this feature well.

The accompanying sketch sections illustrate the relations of the main felsite and slate masses.

Among the purple and green tuff, breccias, agglomerates, and lavas immediately behind the old "Fairfield Hotel," Permo-Carboniferous fossils were found, similar in all respects to those of the slates. Still later, when examining the rocks in Bullock Creek, similar beds of fossils were observed sandwiched in with layers of lava, tuffs, and felsite conglomerates.

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* The felsites themselves will be discussed later in a separate chapter.

† The writer would call attention to the economic importance of this truly magnificent rock. At Malarra and Undercliff (also to a slighter extent at the 15-mile peg on Tenterfield-Drake road) the rock is, perhaps, unexcelled for beauty by any granite known. The contrast of the great pink felspars with the dark setting of hornblende and mica is remarkable. The joints are wide apart and rectangularly arranged.

‡ E. C. Andrews. Geology of New England. Records Geol. Survey N. S. Wales, Vol. VIII, Pt. II, pp. 150, 151.

§ To these typical acid plutonics of New England the writer proposes the name "tin-granites," from heir abundant tin (also bismuth, wolfram, molybdenite, scheelite, and monazite) contents.

In November, 1905, the following Permo-Carboniferous fossils were obtained from highly folded rocks along the Clarence River, a few miles below Rivertree :—

Productus subquadratus, Morris. (Similar to form occurring at Mount Britton, Queensland.)
Eurydesma cordata, Morris.
Deltopecten sub-quinquelineatus, McCoy.

These indicate a Lower Marine age for the beds.

In 1907 the following forms were obtained by Mr. J. E. Carne, Assistant Government Geologist, in the railway cuttings some 6 or 7 miles west of Warwick :—

Productus brachythærus, G. B. Sby.
Spirifera Stokesi (?), Konig.
Martiniopsis subradiata, var. *Morrissi*, Eth. fil.
Crinoid stem.

These are Permo-Carboniferous, probably of Lower Marine age. On the Queensland geological map, they are marked as Gympie. The rocks in which these types occur are indurated clays and shales, interbedded with limestones, andesitic and felsitic tuffs and breccias and thin flaking shales covered with worm burrows. The whole series is excessively folded and faulted, and penetrated by the "tin granite." (*See* plate of sections showing rock structures found in Warwick Railway Cuttings, and Appendix B.)

From Permo-Carboniferous shales and sandstones of gentle dip at Kendall, Mr. J. E. Carne* has obtained *Fenestella fossula* and *Strophalosia;* also *Eurydesma cordata* and *Aviculopecten Mitchelli* from Wauchope. Mr. Carne calls attention to the fact that at Kendall these beds are almost horizontal in disposition, while a little farther west, in approaching the New England Ranges, rocks of similar age are well folded.

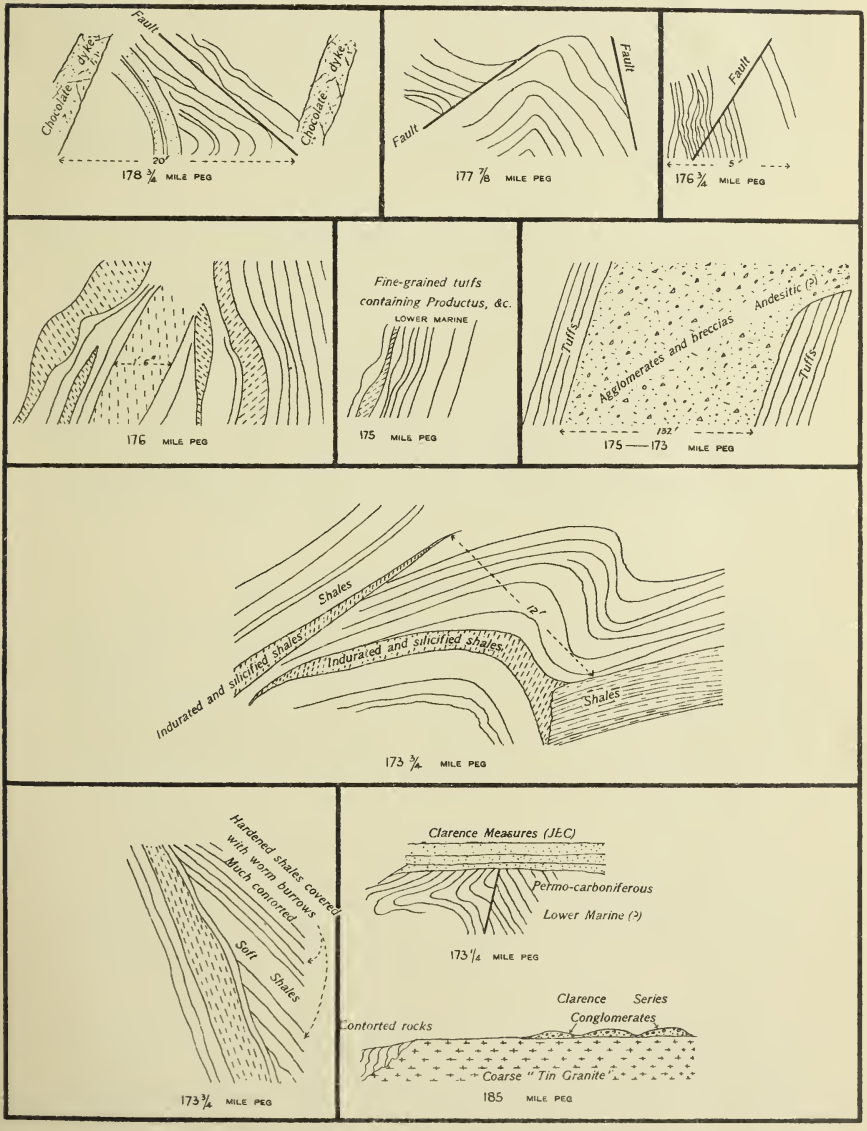
Again, in 1888, from Joagla Falls, about 20 miles east of Hillgrove, Mr. W. Anderson† obtained *Aviculopecten illawarrensis*, *Spirifera tasmaniensis*, and some traces of Fenestella in a limestone boulder.

If, now, the Permo-Carboniferous (Lower (?) Marine) strata, lying between Lionsville and Warwick—a distance of 100 miles—be followed eastward they will be found to pass unconformably beneath the Clarence Series. Having crossed the latter, one discovers a long north and south coastal strip of rocks unconformably overlain by the beds of the Clarence Basin. Their age is, undoubtedly, Palæozoic. They are intensely folded and faulted, and they are quite schistose in many places. No fossils have been found therein, although various observers have made careful search for same at several points between Brisbane and Coff's Harbour, a distance of 200 miles. They are separated from the more western Permo-Carboniferous series by the horizontally-bedded Clarence sandstones and Tertiary volcanics. A traverse across the continuously exposed Palæozoic strata to the south of the Clarence Series might result in the discovery of an unconformity between the two rock types thus exposed east and west of the Clarence Series. Until such work is done, or until such time as determinative fossils shall have been found in the highly contorted rocks of this coastal strip, the relations of the two Palæozoic masses will remain unsettled. On the one hand the eastern strip may represent

* J. E. Carne. Memoirs Geol. Survey No. 6: Lithgow or Western Coal-field, 1907, p. 34.
† Ann. Rept. Dept. Mines N. S. Wales for 1888, p. 190.

Sections in railway cuttings near Warwick, Queensland

Shewing contorted Lower Marine (?) rocks



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Gympie strata forming an eastern boundary to the Permo-Carboniferous sea, or again the two series may represent different conditions of deposition during the same great period of sedimentation.

This fact, however, one may be certain of, namely, that whereas, until quite recently, the Permo-Carboniferous as a factor in the building of New England was considered quite negligible, it has now been shown to be all important. Especially is this seen to be the case when one appreciates the area gained to New England by post Lower Marine and pre-Mesozoic granites. Doubtless more than 50 per cent. of the Palæozoic rocks of New England and associated eastern areas are referable to the momentous Permo-Carboniferous period.

Three interesting problems are thus suggested:—

(1) What is the geographical significance of the undisturbed Permo-Carboniferous south of Sydney, the very gently tilted Maitland strata, and the strongly folded rocks of similar age several hundred miles only farther north, the latter also being extensively intruded by granites of varying age?
(2) What is the relation of the Gympie beds of the Queensland geologists to the northern New South Wales Lower Marine beds?
(3) What, also, is the relation between the coastal Palæozoic beds between Brisbane and Coff's Harbour, and the Permo-Carboniferous separated therefrom by the Clarence Basin sandstones?

The Drake Volcanics.

The lavas of the Drake district present a difficult problem as regards a detailed sequence of events. They are studies in minutiæ. Frequently, within the limits of a 10 or 20 acre block, as many as a dozen rock sub-types may be found. No dips are apparent except in certain of the latest inter-bedded breccia and conglomerate beds. Some of these, moreover, are dips only in the sense that loads of rubbish flung indiscriminately over each other may be said to possess dips.

The rocks of the area are of felsitic and andesitic types. Two periods of volcanic energy are indicated:—

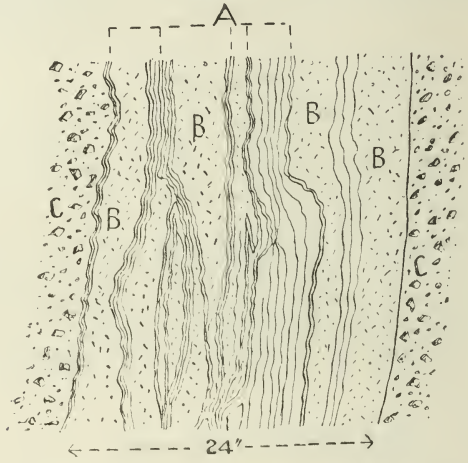
(*a*) One productive of whitish to grey felsites, purple and green lavas, tuffs and breccias, and practically devoid of stratification planes.
(*b*) A younger one, productive of blue and purple agglomerates, breccias, lavas, and tuffs deposited on a sinking sea-floor.

White Rock Gully was the first locality visited in this connection, and hence, as a centre, the sequence of the main volcanic events was made out. The gully is of the long, narrow, steep-sided variety, with an approximately cup-shaped head. At the base of the amphitheatre lies a mass of whitish-grey banded rhyolite breccia, traversed by a network of quartz veins. The grey breccia has been exposed by the removal of a slate and purple breccia cap during the development of the gully by the stream now draining it. It covers some 12 acres of ground. (*See* 3 on General Map.) The quartz composing the banded veins is mostly of the colloid variety. The upper sides of the gorge head are composed of *bedded* purple and green fossiliferous tuffs, associated with similarly coloured breccias and agglomerates. A mass of

columnar felsite and greenish-grey agglomerate forms the highest point of the gorge head. As mentioned previously, a great folded mass of slates and fossiliferous slaty tuffs had formerly stretched across this site.

In this rhyolite breccia patch (*vide* Main Map) numerous large and small bombs of banded rhyolite may be seen. In diameter some are as much as 5 feet. A fine felsitic tuff or lava itself composes the matrix. The accompanying diagrams illustrate this feature.

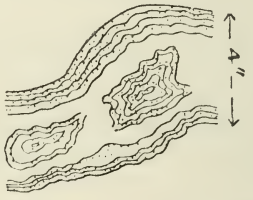
Fig. 2 (a).



Sketch sections of White Rock Reefs.

A, Dark bluish chalcedonic quartz, containing sulphides of silver, lead, and zinc.
B, Whitish quartz.
C, Brecciated felsite matrix.

Fig. 2 (b).



Portion of one of the numerous agatiform quartz-veins between White Rock open cut and battery.
All the quartz-veins in this block show beautiful banding.

The quartz veins traversing this breccia are very interesting. Many of them are combed and intersect each other. At times they exceed 2 feet in width (Fig. 2, *a* and *b*.)

On three sides of the rhyolite breccia, green and purple breccias and agglomerates occur. Their positions are indicated by (9) on the General Map No hard and fast junction with the "White Rock" breccia was observed; no separation of the two by quartz-filled joints or ferrous material;

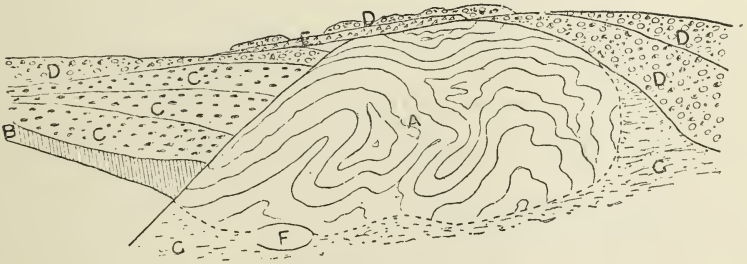
no dipping of the green and purple agglomerates towards the rhyolite mass. Colloid and agatiform quartz-veins cross both masses indifferently, but the main silver-veins appear to be confined to the rhyolite breccia. A couple of shallow shafts sunk in the associated green and purple breccias bottomed in the rhyolite breccia.

To the south and south-west these rhyolite masses are overlain by the stratified purple tuffs and breccias. Here also a fine greyish tuff occurs, apparently dipping at 45° easterly.

It was thought that the underground workings of the White Rock Mine might possibly reveal the connection between the rhyolite breccias and the associated green and purple rocks, but on examination they were found to be confined within the rhyolite mass.

About three-quarters of a mile farther down the valley a small dome of banded grey rhyolite lava outcrops near the stream-channel base. This rhyolite is rather similar in general appearance to the rock of which the "White Rock" breccia is composed. The occurrence, which is some 7 chains in diameter, outcrops on a steep sideling. (*See* [6] General Map.) Near the gorge base this rock is associated (the actual junction was not visible, owing to the thick cloak of waste and vegetation) with green and purple andesitic tuffs. It is, as shown in the accompanying section, buried under green breccias, green and purple agglomerates, and fossiliferous tuffs, which at times

Fig. 3.



Sketch section across banded grey to white felsite in White Rock Gully.

A, Worn-down hill or remnant of old banded rhyolite floor.
B, Green lava of later age.
C, Purple tuffs and lapilli. These beds illustrate horizontal growth of talus after fashion of mullock tip formation.
D, Purple and green tuffs, breccias, and agglomerates.
E, Gently dipping tuff bed full of marine fossils.
F, Remnant of purple porphyry.
G, Waste sheet.
The waste sheet, as also the vegetation, prevents the correlation at this point of the banded rhyolite and the older green and purple porphyries.

show regular bedding, but oftentimes exhibit signs of overlapping such as may be seen in the arrangement of debris dumped over a tip-head, the loads being very variable in size. The whole of the base of White Rock Gorge, as also its middle slopes, is composed of various purple and green porphyries

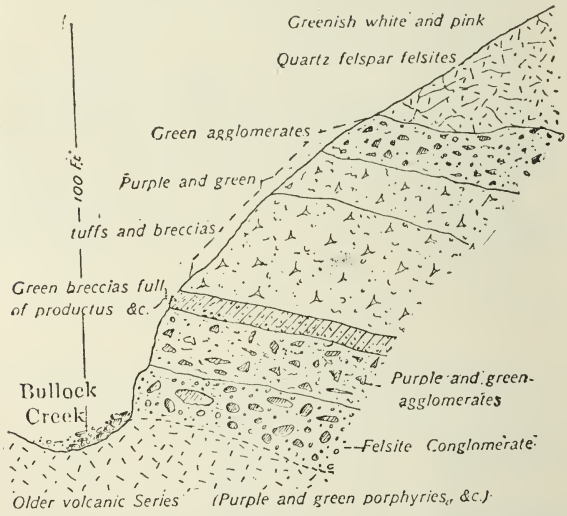
and breccias. Physiographically considered, they appear to be younger than the banded rhyolites and associated rhyolite breccias. All are undoubtedly covered by bedded fossiliferous tuffs and slates, also by purple and green andesitic breccias and agglomerates. The fossils are of marine types and belong to the Lower Marine division of the Permo-Carboniferous period.

In the case of the green tuffs and breccias, the later rocks possess dips at times well defined, the inclinations often determining the pitch of a hillside owing to the differential resistance to erosion exhibited by the beds. Especially well are the bedded newer varieties shown on both sides of the gorge, in the vicinity of the banded rhyolite inlier.

The breccias of Girard's Creek and cuttings may be mentioned in this connection. They belong to the newer series; they are distinctly bedded, and they post-date the newer agglomerate period. In hand specimens they appear as compact porphyries, their fragmentary nature being well exhibited only in field sections. By all gradations they pass upward into fossiliferous tuffs and slates.

One of the most instructive and interesting divisions of the later series (*i.e.*, the purple and green lavas, tuffs, breccias, and agglomerates) is that which comprises the conglomerate beds.

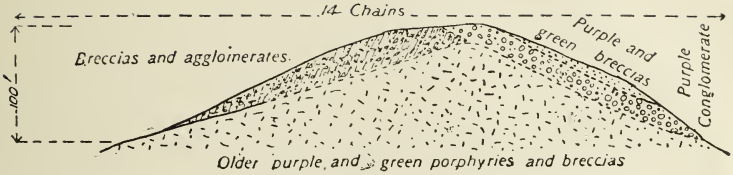
Fig. 4.



Section across older and newer rock series near corner of M.L's. 127, 108, 130, 135, in Bullock Creek.

In many cases a conglomerate bed will contain numerous angular and subangular volcanic blocks; or, again, a conglomerate mass will pass gradually into an agglomerate. Here, commingling of two processes is evidenced—in shallow water agglomerates have been primarily thrown out, where probably the sea reduced the mass to a conglomerate; oftentimes, however, the imposition of fresh agglomerate deluges checked the process of pebble formation. Redistribution with partial to complete rounding by waves of

Fig. 5.



Sketch section on County boundary near M.L. 98.

breccias and agglomerates intermittently discharged from volcanoes is most probably the origin of the great majority of such rock masses.

These were facts observed in one gorge. It appeared that there had been two periods of volcanicity—one probably terrestrial, the other and younger being submarine, but in shallow water. The older demonstration was productive mainly of rhyolites; the younger of andesitic breccias and agglomerates interbedded with marine fossiliferous strata. Agglomerates were common in the rocks of each age. Such coarse masses probably indicate the neighbourhood of centres of explosion, and it may well be that certain masses mark actual vent sites. The rapidly varying nature of the deposits without definite location of foci points rather to small discharges at various times from independent vents. The location of foci of eruption would necessarily be difficult owing to their *small* size, their partial covering by younger strata, and the dense mantle of vegetation.

The surrounding hills and ravines were examined next with a view to testing the accuracy of such assumption. For miles around the same order of events was observed. Masses of old and partially buried whitish, yellowish, and grey rhyolite breccias, agglomerates and lavas were found to abound. Somestimes they exhibited magnificent banding*; at other times they were spherulitic, or studded with quartz and felspar crystals. In every case they occurred as inliers of the fossiliferous slate, tuff, and breccia series, while the similarity of certain of these inliers (as the felsite masses in Cedar-log Creek, Bullock Creek, Saw-pit Gully, and Mount Carrington) to the typical " White Rock " breccia is striking.

Two things were noted in connection with these older whitish grey felsites (and breccias):—

(1) They were invariably overlain by purple and green agglomerates, breccias, lavas, and bedded tuffs.
(2) They were almost uniformly associated with a network of veins containing colloid quartz, and carrying silver, gold, zinc, and galena ores.

In the Drake locality, Mount Carrington is the largest mass of these older exposed rocks. It is a remnant of a much dismantled† volcanic pile which had been covered by the younger lavas, breccias, and agglomerates, and revealed to-day only by the subsequent stripping of the overlying rocks by streams.

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* *E.g.*, the mass 1 mile south of the Adeline (No. 6 General Map), also the lavas forming the south-western slopes of Mount Carrington.

† The dismantlement was the work, first'y, by waves, and, secondly, more recently by streams.

The side of the hill containing the reefs known as The Lone Hands, Parker and Hooten's, The Lady Duff, the majority of the Pioneers, and thence beyond G.L. 115, is composed of spherulitic and banded felsite.

The Carrington, Lady Mary, All Nations, Strauss', the Pig and Whistle, the Baalgammon, and Hot Scone Reefs are in hard felsite breccia, almost identical with that of White Rock, but possessing a finer texture. Other portions of the hill contain blue breccias and soft yellowish grey tuffs. At the Hampden and at Kelly's Silver Reefs (M.L. 41) the typical whitish-grey rhyolite breccia also occurs.

In the felsite breccias of the Hampden Mine colloid quartz networks were not observed. Here the original tuffaceous cementing to the breccia fragments appeared to be replaced by pyrites containing gold and silver values.

At Kelly's Silver-mine (M.L. 41) the typical grey breccia is present and traversed by a network of replacement quartz veins containing silver.

Similarly the green and purple felsite breccias of White Rock and Cedar-log Creeks are traversed by long bands of agatiform quartz. (Fig. 2, *a* and *b*).

Another interesting feature in connection with these older breccias and lavas is the great development therein of bands and masses of jasperoids in the form of bright red opaque ferruginous quartz.

They are common over the field, but are especially massive in the middle slopes of the south side of White Rock Gully, and also in Bullock and Cedar-log Creeks.

In the younger series of purple and green agglomerates, breccias, tuffs, and lavas there is apparently sign neither of these peculiar networks of colloid and agatiform quartz, nor of the masses of jasperoids characterising the older rocks.

These, however, as also the older rocks, are traversed by numerous gold and silver veins, *e.g.*, the Boorook and Lunatic Reefs, the veins in the slaty tuffs above White Rock, &c.

A huge dyke of basic composition crosses Mount Carrington. The dip is easterly at about 45°, and the width varies from 3 to 20 feet. With it are associated gold and copper-quartz reefs A reef may accompany it along its foot or hanging wall, and then leaving it at a small angle gradually "pinch out." Other reefs maintain a rude parallelism with it, and then suffer gradual divergence therefrom with corresponding decrease in size.

The Carrington Reef, which occupies the footwall side of the dyke, is thought by many local miners to consist of a solid mass of quartz possessing defined walls. It, however, comprises a great number of small veins associated with one or two larger fairly defined channels, the country between which has been more or less completely replaced by silica. (Fig. 11, *a* and *b*.)

In other cases (The Lone Hands, &c.) the basic dyke appears from an examination of the stoped-out portions, to have cut across the reefs. This is borne out also by the testimony of the miners, viz., that the reefs were "cut off" by the dyke in these places.

It is probable that the last-mentioned reefs belong to the earlier system of ore deposits.

A dyke of andesitic origin occurs in the older felsites at the Adeline Mine. It is beautifully porphyritic with large felspars, and attains a maximum width of some 25 feet. The dip is westerly at about 45°.

The main Adeline Reef hugs the footwall of the dyke, although at times it is separated therefrom by strips of country rock. Several reefs of varying widths occur in its immediate vicinity on the hanging wall side. They are set closely together and curve sympathetically with the associated inclined wall of igneous rock.

In the case of this reef also it will be seen on examination that, very frequently, the quartz and ore masses are simply "replacements" of country.

Deductions.

As a result of the foregoing observations the following inferences appear to be justified:—

(*a*) The older felsite breccias and agglomerates may mark—

(1) The actual sites of small vents; or

(2) Masses thrown out of various neighbouring small vents.

Certainly, in one or two instances, as at the Hampden Mine, in Sawpit Gully, the rhyolite breccias are crudely bedded and alternate rapidly with differing rock types.

It is extremely probable however, that some of these breccias mark actual vent sites, while others represent ejectamenta situate some slight distance from the discharging vent.

(*b*) The younger green and purple andesitic agglomerates, so well shown on the south and east slopes of Mount Carrington, at Newman's Pinch, and on the White Rock Gorge slopes, occupy a very limited area, and appear to be arranged round a centre situate some half-a-mile south-east of the White Rock Mine.

(*c*) Two periods of ore deposition appear to be evidenced for the Drake district—

(1) One contemporaneous with, and originating in, the decadence of of the older volcanism.

(2) One determined by the intrusion of the later slates and granites by basic dykes.

These periods of ore deposition need a slightly fuller description.

With the decrease in the older volcanic activity, a series of hot springs became the only expression of the dying fires beneath. Cracks innumerable appeared over the surface* and along these water and steam, charged with gases, such as carbonic acid and sulphuretted hydrogen, were given off. These held various silver, lead, and zinc values in solution, which, as the steam and water arose, were, in part, deposited along the sides of the fissures.

At the same time, by similar agencies, the great masses of "jasperoids" were developed.

Denudation was then set up and the upper parts of the volcanic craters were removed. Then came subsidence, and the sea crept over the area. Simultaneously the slumbering fires were again set going; huge piles of agglomerates, breccias, and tuffs were spread over the shallow sea bottom. Sometimes the volcanic fires would slacken and the waves beat upon the agglomerates until they were partly converted into conglomerate beds, while in other places sea shells grew and multiplied. Craters have not been definitely

* The greater portion of the surface is still buried under the younger lavas and slates.

located. Apparently the centres of volcanic disturbance were small and closely set together, so that growing craters were continually tending to bury each other with volcanic débris.

These fires, in turn, became dormant; nevertheless subsidence of the sea-floor still progressed, the while the associated mountain ranges were suffering reduction.

At first the rapid streams swept masses of coarse fragments into the sea area. With continuous subsidence and slightly increasing distance from shore, great thicknesses of slates and fossiliferous tuffs succeeded to the bedded breccias.

Subsequently a force, coming apparently from the east, and acting as a vast slow shoving movement, approximately parallel to the earth's surface (as along the ground from Casino to Tenterfield), turned these flat-lying slates, tuffs, and breccias on edge, slightly only at Drake, but completely* some miles eastwards. In this way another mountain range sprang into existence, and into the heart of the mass granites were thrust at several distinct times.

With the earlier plutonic visitations no mineral deposits of commercial value were associated, but from the youngest members (especially the very "sandy" examples) the tin, bismuth, wolfram, molybdenite and monazite deposits of New England were concentrated into valuable veins.

After these intrusions of granite a great host of diorite and allied dykes burst through the granites and slates of northern and central New England. Their intrusion was the signal for the uprising of heated waters containing gold, silver, lead, and copper ores. In this way the main reefs of Drake, Hillgrove, Rivertree, Howell, and other localities (*e.g.*, Swamp Oak) appear to have been formed.

It does not follow thus that one should expect each member of the New England reefs to be accompanied by a dyke, or that the ores must have been leached out of the same, but rather that these exposed dykes represent some of the highest points of tongues sent out along rock joints from a deeply-seated rock reservoir; that this same reservoir contained much water and acids; and that, subsequently to the dyke intrusions, the water was partly driven off from the cooling mass, and holding ores in solution derived partly from this rock mass, and in part from the older sediments through which they were circulating, had risen most frequently along the cracks determined or widened by the dyke intrusions, and along such planes of least resistance the ores had been deposited. The planes of the reefs frequently coincide with those of dykes, but may be at some little distance away.

Up and along these fissures, then, the heated waters circulated until the fissures were filled. The silica contained in the waters appears to have had a wonderful action on the "country," causing it to pass gradually into impure quartz. (Figs. 3 and 10.)

To the igneous rock types we have been here considering the Adeline and Carrington dykes evidently belong. The association of such dykes with reefs makes for geological permanency. Commercial permanency, however, depends on another set of conditions, to be discussed in a later chapter.

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* To the north and north-east the rocks appear to have been highly contorted and faulted, yet containing fossils of Lower Marine types.

Summary.—The Drake Reefs were formed during two periods—

(1) One, an older, during the hot-spring stage of the rhyolite displays. This was productive of silver-lead veins.

(2) One during the basic-dyke stage, which concluded the granite intrusions. To this period belong the main gold and copper veins of northern New England. (The Howell silver-veins appear referable also to this period.)

As the streams laid low the mountains of the district, these reefs were exposed, and, in turn, gradually washed away. Thus the outcrops we see to-day on the Drake hillsides were, during periods preceding the present, doubtless thousands of feet below the old surface of the land.

The accompanying diagram illustrates roughly a probable mode of origin of these dykes and accompanying reefs.

Fig. 6.

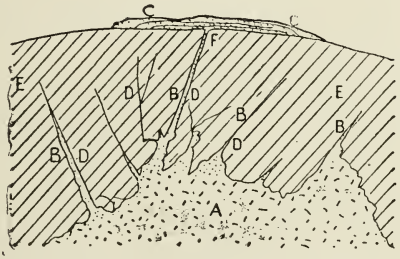

Diagram illustrating dyke intrusions from granite boss.

A is a mass of rock which has worked its way through the slates or felsites, EE. BBB are long tongues or dykes given off by A. Some of these never reached the surface. One, however, at F, has reached the surface and has overflowed, forming the lava sheet, CC.

DDD represent fissures formed alongside or *between* the dykes as a result of contraction of the country. These are filled with ores, segregated, for the greater part, by the hot water derived from the molten mass, A. As the land surface is worn down, these reefs are exposed.

The influence of Topography on the Drake Reefs.

We can here merely enumerate the main steps in the physiography of the Drake district.

1. The mountain ranges formed by the closing movements of the Permo-Carboniferous period were eroded, and the earlier Mesozoic sediments were laid down on their worn-down edges during a period of subsidence.

2. Several times during the Mesozoic period the land surface of New England appears to have been raised and worn down again almost to sea-level.

3. The Tertiary appears to have been ushered in by a decided uplift.

4. Valleys were formed in this surface.

5. Subsidence then ensued, and the river valleys were gradually filled with stream débris.

6. The gold and tin contents of the worn-down associated reefs were swept into these river beds and joggled gradually to the base of the river channels or on to hard layers forming false bottoms to the river drifts.

7. Cracks opened in the New England land surfaces and basalt floods welled thence over the district, burying these old river deposits. (Thus originated our "deep leads." *Example.*—Pretty Gully Lead.)

8. In this land mass a great plain was cut by streams at or near sea-level.

9. The land was lifted gradually, and this plain, now a plateau, was then, by streams, intersected with broad shallow valleys.

10. The country "was again hoisted," by jumps this time for some 3,000 feet.

11. This intermittent uplift gave the streams greater energy, and cutting deeply into the plateau they rapidly formed the magnificent gorges of the Clarence. The Cataract and Drake ravines fall into the latter category.

It is evident, then, that subsequently to the last great uplift the Drake reefs must have suffered heavily from erosion, for the town is now nearly 1,500 feet below the neighbouring plateau; whereas, but a short time ago, geologically speaking, the 3,000 feet-level extended in the vicinity of the Drake township.

As the reefs are gradually removed, portions of their metalliferous contents are washed into the neighbouring watercourses. Thus originate, as mentioned before, our alluvial gold and tin deposits.

Part, however,—and this is especially true for the copper contents of a lode—of the ore material is dissolved by the acids, both in the surface and ground waters. Should the reefs be well provided with joints, such as cross-courses, heads, and slides, the minerals so dissolved will be carried downwards along the reef planes, and, under favourable conditions, be redeposited at varying distances below the surface. The free oxygen in the surface water will tend to form carbonates and oxides in the upper portions, but as the surface water gets mixed up with the ground water, which contains but little free oxygen, the oxidised masses suffer marked decrease in volume, except for certain distances along cracks. The minerals in solution will now, along these cracks, be often reprecipitated as rich sulphurets. (Examples: Copper glance, copper pyrites, bornite.)

Similarly silver will be precipitated as silver glance, ruby silver, &c., while gold will be either thrown down in the free state or bound up in pyrites.

If then a reef be worn away very rapidly, and the ground be *abundantly and strongly* fissured, the copper, gold, and silver contents, when dissolved, may be expected to creep down these cracks and be reprecipitated as *shoots*, *pockets*, or *bonanzas*, both above, and, for a certain distance, below water-level.*

If, on the other hand, the wearing away be rapid and the reefs be not abundantly fissured, the mineral contents will, in great measure, be swept away, inasmuch as they have but little opportunity to creep downwards along the reef. In that case there would be but few *bonanzas*, but rather a general enrichment near the surface, and local enrichments at or near the intersections of reefs and the few crosscourses present.

Now, for New England generally, in late geological time (say the Pleistocene) there has been no widely-spread faulting or mountain making, whereby wholesale fracturing of reefs and country could be accomplished. Locally this applies also to Drake. Small fissures only occur, the country has been worn away very rapidly, and, save for a few minor movements, the district has been undisturbed during the gorge-cutting process.

* For clear accounts of secondary enrichments of ore see—*W. H. Weed*, Genesis of Ore Deposits pp. 473–497; *S. F. Emmons, ib.*, pp. 433 472 and references. *C. Van Hise, ib.*, pp. 282–432.

Ground water-level is also met with generally at slight depths only. Thus we should expect to get at Drake—

(*a*) Fairly rich gold and silver outcrops.

(*b*) Rich carbonates and oxides of copper near water-level and along the reef in the vicinity of certain cross or parallel joints.

(*c*) Rich sulphides near and just below water-level, also along cross-courses below water-level; but the average tenor of the ore, away from these crosscourses, decreasing in value with increasing depth below ground water-level, until at depths of some several hundred feet we might expect to find the original unenriched deposits.

Drake has not been tested to any but slight depths, but so far as the field has been worked, this inference has been confirmed by experience, namely, that secondary enrichments, such as copper glance, bornite, cuprite, and native copper are not found in quantity at other than slight depths below water-level, except in the neighbourhood of crosscourses.

The Drake topography appears thus to have a pronounced influence on the richness of its ore deposits.

It will be interesting to compare the topography, climate, and ore deposits of western New South Wales with those of the eastern portion.

1. We have just seen how the decidedly eastern (coastal) portion of New South Wales is one of pronounced rainfall, recent considerable gentle uplift, and rapid plateau dissection.

2. The western area of the State is one of comparative aridity, of practically stable equilibrium, and has been so during recent geological time. While the New England and Monaro districts have been lifted and rapidly dissected by stream action, the Cobar and Broken Hill reef outcrops have been but little above sea-level; the main ore channels are large, and reef removal by streams is reduced almost to a minimum.

We would, therefore, in such a region, look for large masses of oxidised ore near the surface, and for considerable masses of rich sulphurets to be both associated with the oxidised portions and to occur below them. Heavy faultings in older times are not considered in this connection. The Broken Hill* and Cobar ore occurrences appear to justify this conclusion.

Summary of Drake Reefs.

1. In point of numbers the reefs are important. They are, however, narrow in width.

2. Geologically considered, they may be considered fairly permanent.

3. Commercially they are dependent for success on a cheap metallurgical process, the *bulk* of the richer secondary ores having been already won.

Description of Reefs.

The information supplied in the following pages concerning the Drake reefs is very imperfect, because the greater number of the mines have been abandoned for years and the shafts are almost full of water.

1. *White Rock.*—The ore deposits known as the "White Rock" consists of networks of agatiform colloid quartz veins traversing a small mass of

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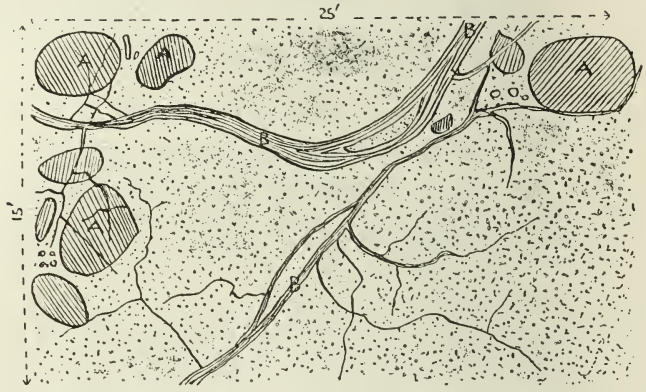
* *J. B. Jaquet,* Geology of the Broken Hill Lode: Mem. Geol. Survey N. S. Wales, 1894.

rhyolite breccia and associated purple, green, and grey tuffs, breccias, and agglomerates. They are confined to the older volcanics only, and appear to be referable to a decadent phase of volcanic action prior to the later period of volcanism. The "White Rock" breccia, in which these quartz networks are characteristically developed, occupies the base of a gorge, and is approximately elliptical in shape. The mass is, for the most part, composed of fine angular fragments of banded rhyolite, but in one spot a great development of roughly spheroidal bombs occur.

Fig. 7 (*a*) illustrates the occurrence of these bombs in one portion, and Fig. 7 (*b*) illustrates their distribution in another portion of the mass.

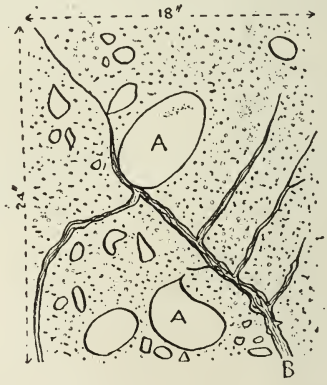
Fig. 7 (a).



Illustrating occurrence of volcanic bombs and colloid quartz-veins at White Rock.

A, Felsite bombs.
B, Colloid quartz veinlets. The country is of felsite, breccia, and tuffs.

Fig. 7 (b).



White Rock bombs and quartz-vein networks.

A, Volcanic bombs (banded rhyolite).
B, Colloid quartz veins, banded, and containing silver, lead, and zinc. The country is a fine-grained rhyolite, breccia, and tuff.

Both the figures illustrate the association of bombs, breccias, and colloid quartz-vein networks.

The mass varies much in texture from point to point.

Partly encircling it is a mass of coarse and fine tuffs, breccias, and agglomerates of different character to the "White Rock" breccia. These merge gradually into, and are in places overlain by, purple and green porphyries. Above all, and occupying the higher points of the enclosing amphitheatrical valley, comes a mass of conglomerates and interstratified tuffs, breccias, and lavas. Lenticular patches of younger agglomerates also occur.

The amphitheatre is the work of a small stream during and post-dating the last great intermittent uplift, which formed the present plateau of New England. With the removal of the upper stratified series the "White Rock" breccia and associated rock masses were exposed. The rhyolite breccia, offering great relative resistance to stream action survives as a dome in the gully base.

Mr. E. F. Pittman has explained the "White Rock" breccia as a volcanic neck, and the networks of quartz-veins therein, containing silver, lead, and zinc values, as a result of later action in the "neck." The disposition of the large bombs apparently supports this view.

A comparison with similar neighbouring occurrences may be of interest—

1. In the same gully, and some 70 chains distant, a banded rhyolite flow occurs as an inlier, almost buried under later agglomerates, tuffs, breccias, and lavas. Its superior resistance to stream action is shown by its contour.

2. Under the fossiliferous marine slates and tuffs, 1½ mile south in Cedar-log Creek, patches of rhyolite, breccias, and lavas almost identical with "White Rock" breccia occur.

3. In Lower Cedar-log Creek, some 2 miles south-east of White Rock Mine, a dome of rhyolite, breccias, tuffs, and lavas occurs, associated with old purple and green porphyries. Through all these rocks a great network of colloid quartz-veins runs, as also the "jasperoids" mentioned in the earlier pages of the report.

4. Almost identical conditions obtain some half mile north of the example cited in the previous paragraph.

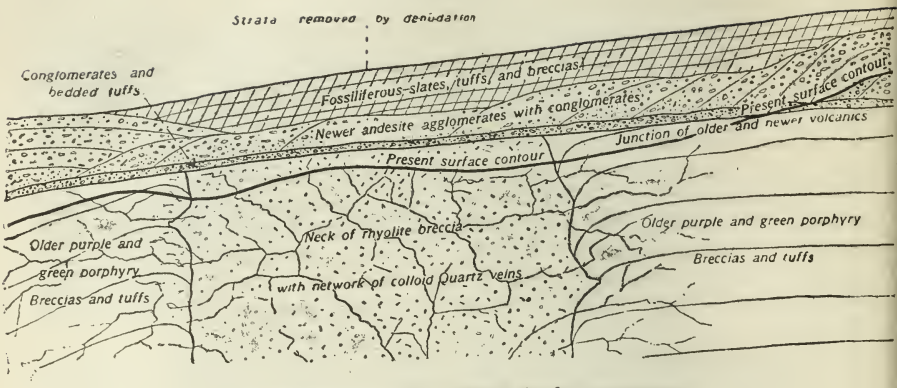
5. A mass of rocks, embracing some 100 acres in area, occupies the township of Drake south of the main road. These are of various felsites, but the characteristic rock-types is a rhyolite breccia presenting great affinities with the "White Rock" breccia. At the Adeline Mine this breccia appears to form a *shallow horizontal bed* overlying green and bluish-grey felsite, tuffs, and breccias with bombs.

6. At M.L. 41, some 3¼ miles north-east by east of White Rock, a rhyolite breccia occurs, associated with yellowish and greenish-yellow tuffs of the older volcanism. The mass is crossed with a network of colloid quartz-veins carrying silver sulphides. The resemblance to the White Rock occurrence is striking.

7. Mount Carrington, from 2 to 3 miles north-east of White Rock, consists of layers of rhyolite breccia, banded lava, green and yellow tuffs. These are all overlain by the later volcanics. The rock-types are strikingly similar to those of White Rock. A similar wealth of quartz-veins network also occurs at this spot.

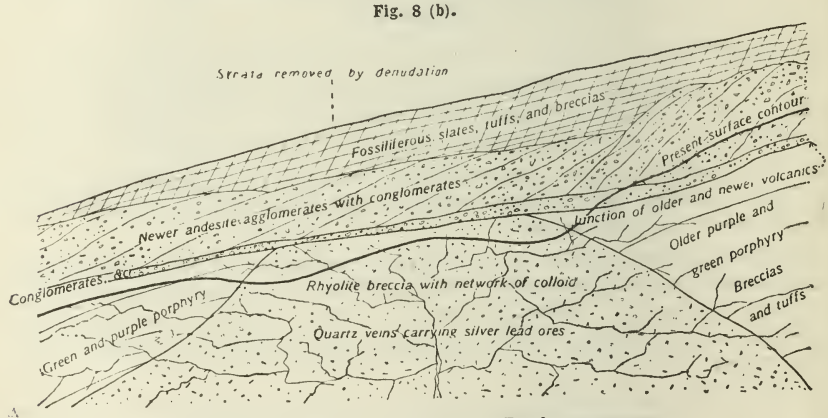
Fig. 8 (a).

IDEAL SECTIONS.


Strata removed by denudation
Conglomerates and bedded tuffs
Fossiliferous slates, tuffs, and breccias
Present surface contour
Newer andesite agglomerates with conglomerates
Junction of older and newer volcanics
Present surface contour
Older purple and green porphyry
Neck of rhyolite breccia
with network of colloid quartz veins
Older purple and green porphyry
Breccias and tuffs
Breccias and tuffs

One explanation of the White Rock occurrence.

Fig. 8 (b).


Strata removed by denudation
Fossiliferous slates, tuffs, and breccias
Present surface contour
Newer andesite agglomerates with conglomerates
Junction of older and newer volcanics
Older purple and green porphyry
Breccias and tuffs
Conglomerates &c.
Rhyolite breccia with network of colloid
Green and purple porphyry
Quartz veins carrying silver lead ores

Another explanation of the White Rock occurrence.

Of course, in an area such as that under description, volcanic necks must be of more or less frequent occurrence ; but in a mass of closely associated rhyolite, breccias, and agglomerates, with other and younger *coarser* agglomerates occupying almost the whole of the intervening spaces, it is difficult to locate foci of eruption. Especially is this so in an area of dense plant undergrowths, in an area also where great developments of newer rocks prevent direct correlation of two neighbouring patches of older volcanics; and where no lines of junction can be obtained between two varying types of rock.

Apparently all these rhyolite inliers showing great developments of colloid quartz-vein networks and alteration of country to "jasperoids" represent the stump of a felsite volcano, or a volcano on the shoulders of which a series of parasitic craters had been developed, or a series of independent volcanic piles. The development of colloid quartz-veins arose as a dying phase before denudation and the later submarine volcanism.*

* One centre for the later agglomerates (as seen at Newman's Pinch, Mount Carrington, Bullock Creek, and White Rock Gully) appears to have been near the old "Fairfield Hotel."

The following notes on the White Rock property were supplied through the courtesy of Mr. L. Gundlach, manager of the Adeline and White Rock properties:—

A vertical shaft 180 feet deep was sunk in the breccia. Two drifts thence were run, one north and one south. The northern drive (110 feet) did not develop any ore body. The southern one (132 feet) showed ore near the shaft with a barren stretch of 25 feet. Thence a succession of veins of all sizes occurred, until at 130 feet the "galena" lode was struck. This was said to be approximately 10 feet in width and without gangue over a 60-feet long exposure. This averaged from 30 to 40 oz. silver. (L. Gundlach.) The 60-feet exposure does not represent the whole length of the "galena" lode, but merely that portion of it developed in prospecting operations south.

Veins were struck all the way down the shaft. One very steeply-dipping example, about a foot in width, remains in the shaft face about 70 or 80 feet down and carries gold values.*

Originally the property was floated for £1,000,000 (?). A costly plant was erected. This scheme naturally soon collapsed.

Ten years later Mr. John Howell floated the property for £175,000. Dams were constructed, roads cut into the jungle, and a mining plant erected at a cost of from £36,000 to £40,000.

This venture soon failed, and the property was handed over to the Smelting Company of Australia (Dapto). The latter company lost control at a later date owing to non-fulfillment of labour conditions.

The original company erected a 60-head battery and a set of Frue vanners. Fine crushing was adopted, and the principal ore values thus passed into the slimes and were not recovered by the Frues. No provision was made for slime treatment.†

The second company did not adopt fine crushing. The ore was crushed to six holes per linear inch, and concentrated on jigs. The tailings are said to be nearly as rich as the concentrates, assaying something like 12 oz. silver per ton.

The following experiments were carried out on the tailings by Mr. Gundlach:—

(1) They were crushed through a 30-mesh (linear) sieve in such a way as to produce very little slime; the resulting pulp was very carefully panned.

The concentrates yielded on assay some 23 oz. silver per ton, while the new tailings assayed 11 oz. per ton.

(2) The ore was ground through a 30-mesh sieve and treated twice with oil. The first concentration assayed 81 oz. silver per ton. The second concentration assayed 16 oz. silver per ton. The tailings assayed 7 oz. silver per ton.

(3) The same ore was crushed and passed through a 60 (linear) mesh sieve; oil concentration was adopted. The first concentration assayed 60 oz. silver per ton; the second concentration assayed 9 oz. silver per ton; tailings assayed 3·5 oz. silver per ton.

This represents approximately a 75 per cent. recovery, and suggests necessity of extraction by sliming.

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* A sample sent from this vein by Mr. J. P. Curran to the Mines Department yielded an assay value of 13 dwt. gold to the ton.

† The silver sulphides are very soft and the rhyolite country very hard.

The following is an account of a treatment of the White Rock ore by water concentration :—*

REPORT ON THE TREATMENT OF THE "WHITE ROCK" ORE BY THE LÜHRIG SYSTEM, FOR THE AGENT-GENERAL OF NEW SOUTH WALES.

The ore, which I was requested to have tested by the Lührig Concentrating System, on behalf of the Government of New South Wales, was stacked in the ore stores of the "washer" of the Gute Gottes Mine, at Scharfenberg, on the Elbe, near Meissen, Germany.

It was contained in 202 bags, marked W.R., in all about $10\frac{3}{4}$ tons. In character it was a mixture of light grey and nearly white siliceous and felspathic rock, containing more or less fine-grained pyrites and galena; the lighter portions appeared to be almost barren of ore—so much so as to cause the skilled working ore-dressers of the place to consider that portion worthless, and to suggest hand-picking to sort out the mineralised pieces. The whole bulk of the stuff, without any picking, was sent to the machinery for treatment.

A few pieces, taken indiscriminately from the bags in London, before they were sent to Germany, gave by assay:—Lead, 1·37 per cent.; silver, 43 oz. 5 dwt.; gold, 2 dwt. to the ton.

A sample carefully taken at Scharfenberg from the whole bulk, gave by assay:—Lead, 1·50 per cent.; silver, 39 oz. 4 dwt.; gold, traces to the ton.

The plant at Scharfenberg, one of Lührig's most simple systems, was designed for and is treating a poor siliceous ore, containing fine-grained galena blende and pyrites. On this "washer" the White Rock ore was easily treated, and gave most excellent results.

The concentrates produced gave by assay:—

	Lead.	Silver.	Gold.
Jigger concentrates...	57 %	0·74 %=241 oz.	0·0002 % to the ton.
Vanner " ...	55 %	0·73 %=238 oz.	0·00025 % " "

The assays were made by the Government officials at Freiberg. The results from the final tailings showed only traces of metals.

To obtain these results the material was worked with a view to the avoidance of loss.

Herewith I attach a copy of Herr Lührig's report. It will seem that he bases his estimates on a plant capable of putting through 1,200 tons of ore in a day of three eight-hour shifts. He also provides for sending the concentrates to Europe. Not knowing any of the local circumstances, mining expenses are excluded from the account. He makes the following statement:—

"Seven and a half tons of ore similar to the sample will yield 1 ton of concentrates, containing 228 oz. of silver; the latter being the important metal of the ore, gold and lead contents are not taken into consideration.

"Although the London assay showed 2 dwt. to the ton, none of the Freiberg determinations gave anything more than traces."

It can be seen by comparison between the assay returns of the products and Herr Lührig's statement, that he has allowed the very large margin of about 22 per cent. for contingencies, his reasons being:—When putting through large bodies of this class of ore, to make a comparatively high loss is often the more profitable procedure, owing to the cost of working being thereby cheapened, and the amount of machinery considerably lessened. Also with similar ores he has found that variations of the mineral contents are often met with, and in making his statement he has allowed a heavy margin for contingencies.

The result of this practical test has satisfied me that the Lührig system of concentrating is admirably adapted for the treatment of these ores.

Mr. Florence O'Driscoll was present with me at Scharfenberg, jointly making other tests. He also observed the working of the White Rock ores, and fully concurs with me in my conclusions.

COSMO NEWBERY.

Several veins, averaging 18 inches in width, traversing the open cut workings, are being worked at present by tributors. Almost the whole of the vein material is taken. The contained silver sulphides are very fine in character, and they are not particularly associated with baser sulphides.

* Extract from Ann. Rept. Dept. Mines N. S. Wales for 1891, pp. 44 and 45.

The following figures, representing the ore won by the tributors during the last two years, are taken from the Cockle Creek and Dapto Smelting returns:—

250 tons for an average per ton of—95 oz. silver; 4 to 5 per cent. lead; 10 to 12 per cent. zinc.

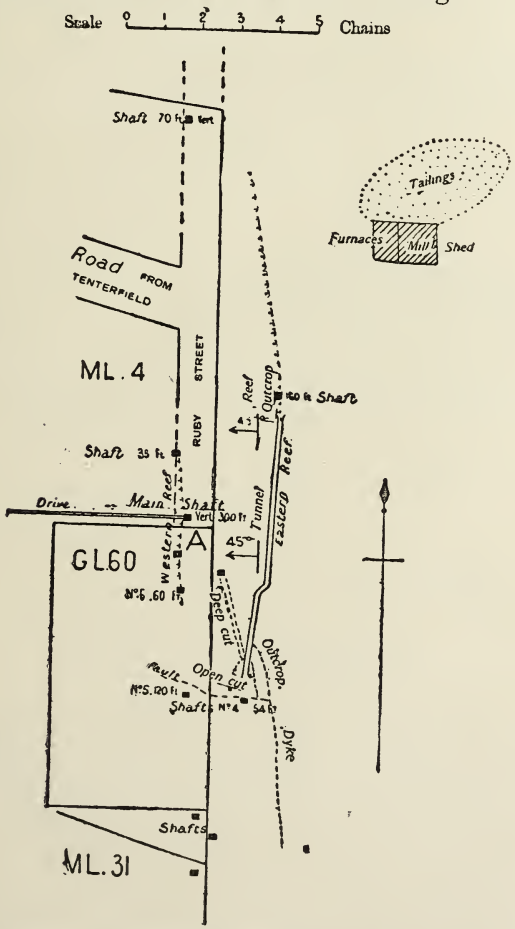
The Adeline Mine.

The country (*see* General Map) consists of the older volcanics. The outcrops of the reefs are in typical rhyolite breccias, apparently horizontally bedded.* Subjacent to these are blue and grey felsite breccias and tuffs containing bombs.

The reefs, several in number, curve sympathetically with each other and with a large porphyritic andesite dyke, which has apparently determined the ore entries. All dip westerly at an angle of some 45°.

Fig. 9.

Plan of the Adeline Mine workings

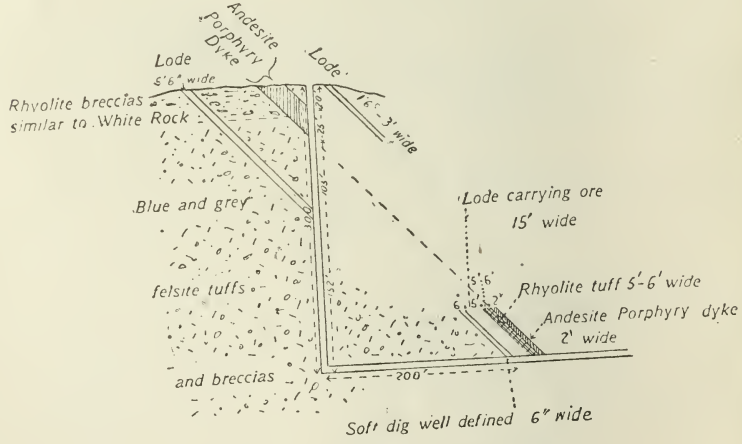


* The country at this spot occupies the base of a shallow fold.

The accompanying plan (Fig. 10) shows the disposition of the workings. In the earlier exploitations shafts were sunk on the reefs to depths of about 100 feet, and a long low-level tunnel was driven on the main line of reef. The ores were copper and gold, and the gangue contained a considerable percentage of iron pyrites. A small reverberatory furnace was erected to treat the ore, fluxes being obtained from Black Creek, some 13 or 14 miles to the east.

At a much later period (1903) a shaft was sunk for 300 feet. [Fig. 10.] Fig. 11 illustrates the testing of the reefs during this period. The reefs dip westerly, and the shaft was sunk vertically at a distance of about 150 feet from the outcrop. At a short distance from the surface the large andesite dyke was passed through (here some 20 feet thick). 150 feet from the surface the lode was cut 6 ft. 6 in. thick (B). At 300 feet down a crosscut was put into the west. At 200 feet a "dig" 6 inches in width was passed through, thence for 15 feet lode matter carrying ore (copper and gold); to this succeeded 5 or 6 feet of rhyolite tuff. Immediately on passing the tuff an andesitic dyke, strongly porphyritic with felspar crystals, was met. The dyke here had practically identical characters with the larger mass cut by the shaft at 150 feet. The idea entertained at the time was that this small dyke was merely a branch of the main andesite mass, and the crosscut was continued for a considerable distance with no results.

Fig. 10.



Sketch section across Adeline Reefs.

During my examination of Drake, the Adeline workings were filled with water, but the observations as shown in the section apparently evidence the local pinching of the dyke in the crosscut. Were a drift to be run along the lode formation both north and south, the dyke would most probably be found to gradually widen. Local contractions of dykes are not infrequent; as a matter of fact, the large dolerite (?) dyke of Mount Carrington pinches in width from some 20 to 3 feet in a distance of about 4 chains.

Previously to this exploitation, the management won over 600 tons of ore averaging 3 oz. gold and 9 per cent. copper, and from 800 to 900 tons, averaging 13 dwt. gold, and from 4 to 5 per cent. copper.

Mr. L. Gundlach has cyanided over 4,000 tons of tailings for a recovery of 5 dwt. gold per ton. The difficulty of treatment consisted in eliminating the copper admixtures.

For treatment of the tailings, five 20-ton tailing vats and three solution vats were employed. The vats were filled by hand. No taps were used, short lengths of rubber being employed for directing into waste, overflow, or wash water, or into the solution pipe leading to the zinc box. The tailings were washed. The solutions varied from 20 to 40 per cent. in strength. Three solutions were used. Lime and caustic soda were also employed. The copper admixtures ranged from mere traces to ·50 per cent. of the mass, chiefly as sulphate. The treatment lasted five days. The recovery was 70 per cent.

The slimes were also treated.

Between the years 1888 and 1904 the Adeline Mine yielded £31,037* sterling in copper and gold values. At the present time the total value of the ore treated approximates to £40,000 sterling.

The Carrington.

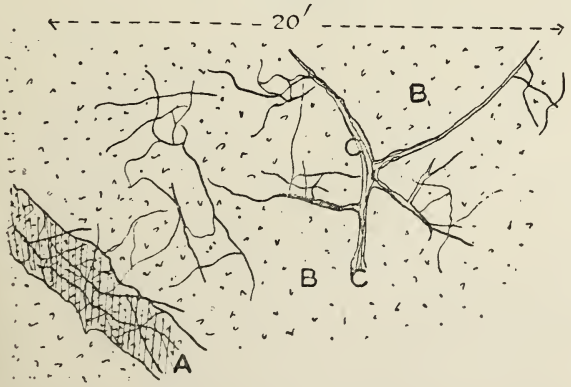
This property occurs on a hill behind the township of Drake, about 550 feet in height. The eminence is composed of the older volcanics, and rhyolite breccias occupy that portion traversed by the Carrington outcrop. The breccia is very similar to that of the White Rock Mine.

A large dolerite (?) dyke, some 20 feet in width and dipping easterly at about 40°, appears to have been responsible, in part, for the formation of the Carrington and associated reefs.

The Carrington occurrence is rather a series of small quartz veins assuming parallelism of strike with the dyke for a certain distance, and gradually diverging therefrom to the south. An older network of quartz veinlets is apparently referable to the earlier volcanic period. Great silicification of the country traversed by the Carrington Reef and veinlets is noticeable, the original brecciated structure being plainly discernible in the silicified masses. Fig. 12 (*a*) and (*b*) illustrates this silicification of the rhyolite breccia.

Diagrams illustrating method of occurrence of Carrington Lode.

Fig. 11 (a).

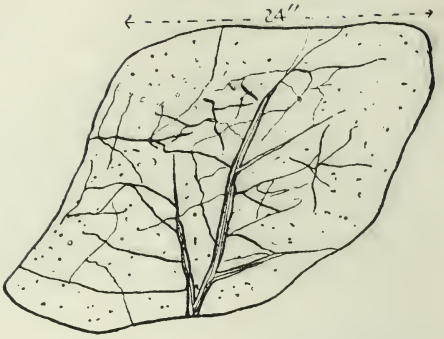


A, Mass of rhyolite breccia, altered in great measure to quartz by network of quartz veinlets.

B, Mass of rhyolite breccia, almost completely altered to quartz by the masses of quartz veinlets (C) traversing same.

* For these and succeeding values of mine yields I am indebted to Mr. J. P. Curran, of Drake.

Fig. 11 (b).



Block of stone along Carrington outcrop, changed to quartz by the network of quartz veinlets traversing same.
The structure of the breccia can be distinctly seen.)

The Carrington Reef in the prospecting stage was worked for gold. An underlay shaft (40°) was sunk for 320 feet, and levels thence were run to secure the precious metal. The greater portion of the reef alongside the shaft has been stoped. The gold values were considerable in the cap, but suffered rapid decrease with depth. A vertical shaft was, at a later date, put down to the east. At 150 feet the dyke was passed through, and a drift of 26 feet thence to the west cut the main reef. The intervening country consisted of rhyolite breccias and tuffs, crossed with quartz veinlets from which as centres silicification was noticeable.

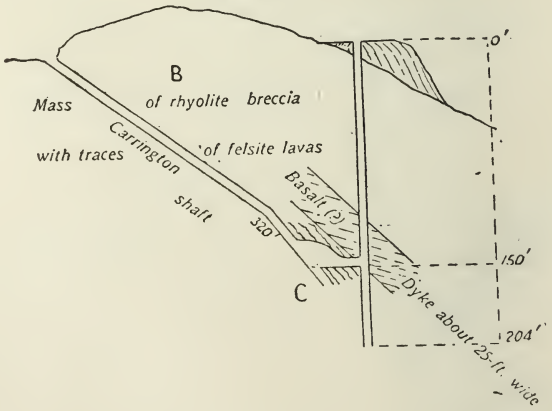
Fig. 12 (*a*) and (*b*) illustrate the relations of the reef, dyke, and shafts.

At the 300-feet level along the underlay shaft copper stains were observed in the reef. It is probable that from this point to water-level the copper values will decidedly improve.

The amount of gold won from this reef since 1888 is estimated at £5,555.

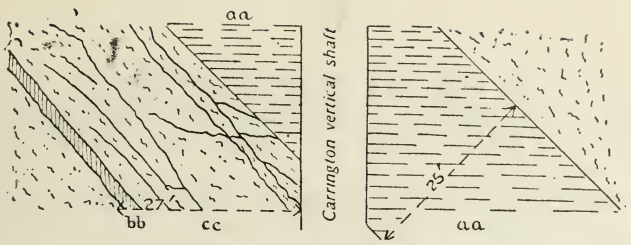
Diagrams illustrating occurrence of Carrington Reefs.

Fig. 12 (a).



(*a*) General relation of Carrington shafts, dyke, and reef.
B, Mass of rhyolite breccia 30 feet wide, underlying dyke and crossed with quartz veins.

Fig. 12 (b).



(*b*) Enlargement of " B " in (*a*).

AA, Basic dyke some 25 feet wide.
BB, Quartz-vein, about 12 inches wide, carrying copper and gold.
CC, Mass of rhyolite breccia and lava turning into quartz by reason of numerous quartz-veins traversing it.

The Lady Jersey Mine.

The property of this name lies some 6 miles south of Drake in Long Gully. The country consists of stratified tuffs, intruded by dark felspar porphyries. A large intrusive mass of sphene-hornblende granite lies some 700 or 800 yards to the south.

Although a locality from which £60,000 worth of gold has been obtained, the mine has been practically abandoned, and the workings are now almost filled with water. Above water-level the ore bodies have been stoped to the surface. Nowhere during my visit was there a sign of reef visible in the upper workings.

The reef evidently post-dates the granitic intrusions, and, therefore, belongs to the newer period of reef formation in northern New England.

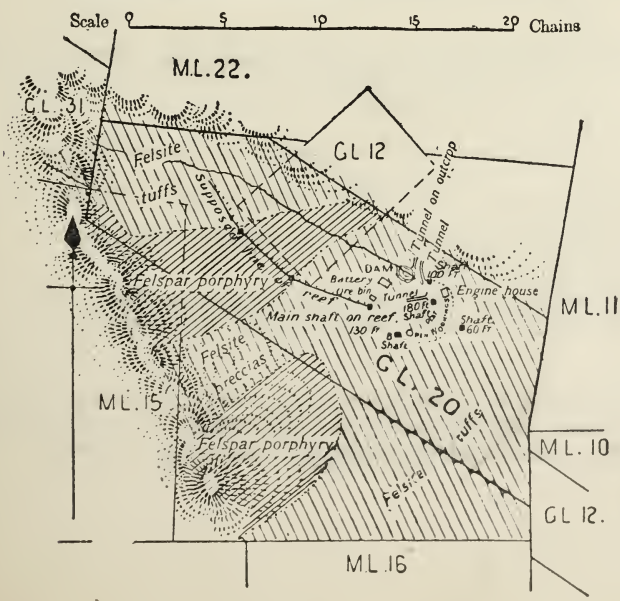
The appearance of the stopes are such as to strongly suggest the formation of a very narrow fissure, from which pronounced silicification and mineralisation of the " country " resulted in the form of large ore lenses.

The ore is gold, the gangue being mainly quartz with abundant zinc blende, and smaller amounts of copper and iron pyrites.

The accompanying plan (Fig. 13) illustrates the occurrence.

Fig. 13.

Plan of the
Lady Jersey workings at Long Gully



The Lady Mary and Lady Mary Extended.

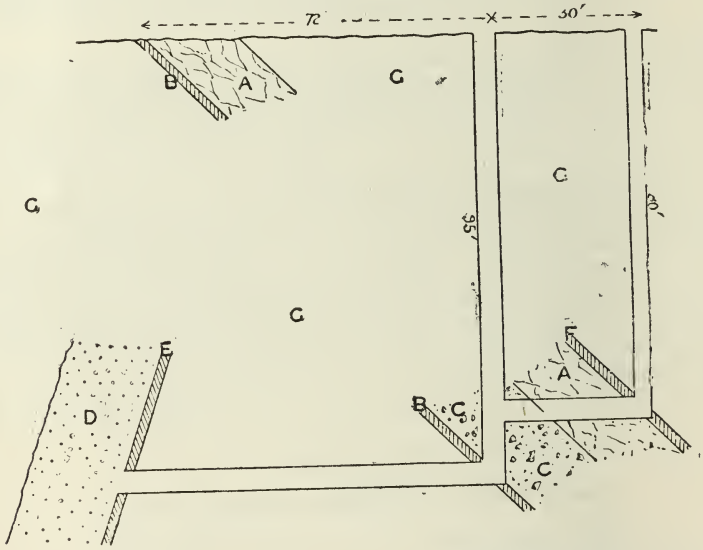
The soft basic dyke and reefs of the blocks under consideration appear to be continuations of the Carrington line. The country is a rhyolite breccia of " White Rock " type.

Fig. 14 illustrates the relations of the various reefs, the dyke, and workings. A vertical shaft, 83 feet deep, proved the basic dyke. A crosscut, 23 feet in length, was put through the dyke, thence for 15 feet west. Silicification of country was noticeable, and a strong quartz reef was cut (The Carrington).

Another vertical shaft was sunk a little to the west, which cut the dyke at 70 feet, and the (Carrington) reef at 90 feet.

A drift was run thence 45 feet south, then 22 feet south-west, and continued about 60 feet west. This cut the Lady Mary Extended (The Red Reef) possessing a dip of 60° westerly.

Fig. 14.



Sketch section illustrating occurrence of Carrington and Lady Mary Reefs in McCrossan and Party's workings.

A, Basic dyke, dipping east at 45°.
B, Carrington Reef.
C, Mass of felsite breccia underlying dyke, being converted into quartz by small quartz-veins.
D, Pipeclay formation 20 feet wide (crushed (?) felsite), carrying numerous veins of copper glance.
E, Vein of quartz carrying gold and copper (Lady Mary Reef).
F, Quartz reef 2, feet wide.
G, Felsite breccias.
All these features have been treated as though in one plane.
A shaft, 140 feet deep, has also been sunk, from which the ore at D and E is being won.

This shows a reverse of dip as compared with the Carrington (Fig. 12*a*). The Lady Mary Extended forms a continuation of the Lady Mary Reef, and is a strong quartz reef containing gold and copper values.

At first glance an intersection with the Carrington Reef at a higher level is suggested, but the evidence of the present exploiting party (Messrs. McCrossan) suggests the occurrence of a fault which has cut the reef off at a higher level. The stopes being mullocked up, I was unable to ascertain the accuracy of this statement.

Immediately above this reef is a clay formation (with slight traces only of quartz) containing numerous impregnations and veinlets of copper-glance with rarer nodules of copper carbonates.

A vertical shaft was sunk 147 feet to win this ore body. One of the chambers excavated in the clay formation, which is either a decomposed dyke or an altered rhyolite breccia, exceeded 22 feet in width, and from it, according to Mr. J. Lukey, of Drake, £3,000 worth of copper, exclusive of smelting charges, was won. By concentration at Sawpit Gully also with batteries, Wilfley tables, and Frue vanners, £700 worth of copper, and £800 of gold were obtained.*

The clay formation was extracted for some 30 feet below the new shaft. Here copper glance values were still obtained, and there was no sign of water-level. There is no reason to doubt the continued existence of these rich copper contents to water-level, and to some little distance below that level. Below that the glance will doubtless give place to much leaner pyrites.

The Pioneer workings.

The Pioneer Reef is strongly marked, and runs clear across Mount Carrington. Its dip is about 45° westerly, and it has been worked by three underlay shafts. No. 1 shaft is about 200 feet, No. 2, is 80 feet, and No. 3, 180 feet in depth. All three shafts are connected, and considerable stoping of the reef has been effected. Recently a winding tunnel has been driven in what, most probably, is the lower development of the Pioneer. In total length the drift is about 1,000 feet, and at a spot vertically beneath the hill crest traversed by the reef outcrop, is 300 feet below the surface. The width of the reef is variable, averaging from 1 to 2 feet. The ores are gold and copper; the gangue is quartz, with about 15 per cent. of pyrites. The country along the upper levels consists of greyish-blue rhyolite tuffs breccias and agglomerates, while along the lower levels it is of breccias and banded (?) rhyolites.

The position of this line of reef is indicated on the map of Mount Carrington. The value of the ore raised from the Pioneer Reef up till 1905 was about £7,000 sterling. Since that date the long low level tunnel has been driven on the reef revealing fair values of gold and copper.

The Mascotte.

A considerable amount of work has been carried on in this locality. (*See* Fig. 15, also General Map.) The ore mined for is silver and the country consists of rhyolite breccias of types similar to White Rock and Mount Carrington. Native silver and silver sulphides occur.

The mine has been practically abandoned for several years past. No opportunity offered for examination of the workings.

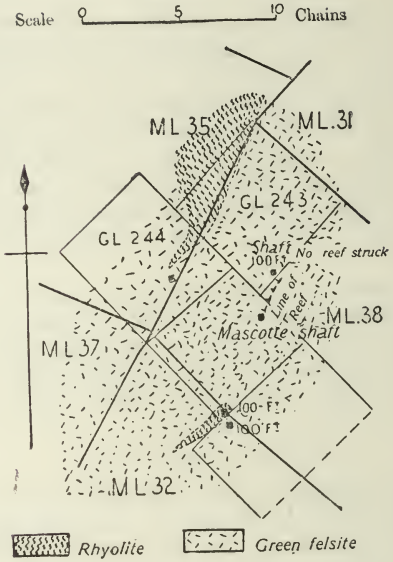
The amount of ore won between the years 1888 and 1904 was valued at £8,882.

* The yield of the Lady Mary was £6,264.

Fig. 5.

Plan of the workings at

The Mascotte Mine



Plan of Mascotte workings.

The Hampden.

This mine occurs in Sawpit Gully, 1 mile north of Drake. The country consists of rhyolite breccias, grey and yellowish and bluish-grey in colour, and very similar to the rocks occurring at the Carrington and Lady Mary workings, about a mile distant. Several shafts, varying in depth from 100 to 200 feet, have been sunk and crosscuts have been run therefrom to exploit the ground. The breccias have a rude arrangement in layers. No decided vein appears to have been encountered, the ore occurring in a breccia, throughout which the original cementing material has been replaced by pyrites containing gold and silver values. The ore bodies, which appear to be of considerable size, are reported to be worth about 25s. per ton.

The ground being abandoned in 1904, no opportunity was offered of examining the ore masses *in situ*. The occurrence, however, is probably due to the gaseous and hydrothermal action of decadent volcanism on the rhyolite breccias.

A large and expensive plant was erected to treat the stone. The battery (20-head of stampers) was obtained from the White Rock plant. Frue vanners and Wilfley tables, as also a cyanide plant, were erected.

The amount of ore raised was valued at £3,473.

All Nations' Claim.

This property occurs at the head of Sawpit Gully in rhyolite breccias and tuffs of the characteristic Mount Carrington types.

The ground was exploited by means of a shaft 150 (?) feet deep, also by cross-cuts and tunnels. The reef or reefs were not examined on account of the discontinuance of mining operations here for several years past.

The ore is gold, the gangue being a pyritous quartz.

A battery was erected to treat the ore.

The value of the ore raised since 1888 was £6,216.

Strauss' Claim.

These workings have been abandoned for some considerable time. They consist of an open cut, several shafts, and a tunnel driven in from Sawpit Gully. The open cut yields a section of bedded breccias and tuffs. A belt of conglomerate appears to have been traversed by a shaft sunk at the mouth of the tunnel. The value of the ore raised was £2,619.

The Pig and Whistle.

The reef of this name is a well-defined fissure vein near the Lady Mary property, traversing rhyolite breccias of the ordinary Mount Carrington types. The dip is easterly, having a value of 70° in the upper, and of 50° in the lower, portions of the reef. The depth attained was 130 feet on the underlay. Thence to the surface, alongside the reef, a considerable amount of stoping has been carried out. A drive 150 feet long was put below the 100 feet level.

The ores are gold and copper, and the gangue is quartz, containing about 15 per cent. of pyrites and zinc blende.

Upwards of 2 oz. gold per ton occurred along the upper levels, and about 1 oz. 15 dwt. per ton at the bottom. The copper amounted to about 4 per cent. as copper glance, cuprite, and native copper. At 100 feet a flat crosscourse was met. Intersecting both this and the reef is a small vertical crosscourse. Along this, and in its vicinity, the reef material consists of beautifully crystallised cuprite and native copper.

Water level was met with at about 70 feet below the surface.

The value of the ore raised between the dates 1888 and 1904 was £2,593.

The Perseverance.

This is a well-defined fissure vein, occurring in rhyolite breccias, near the summit of Mount Carrington. Several shafts were sunk to exploit the reef, the two most important being 90 and 76 feet deep. The dip is about 50° to the north-west. Fig. 14 illustrates the method of working the vein. The width varied from 2 to 4 feet. The gangue was white quartz with considerable percentages of iron pyrites and zinc blende.

The ores were gold and copper.

The value of the ore raised was £2,016.

Parker's Claim.

This property was exploited by means of two shafts and a connecting driver; the southern shaft is 96 feet and the northern one 140 feet in depth. The reef has a dip to the east, varying in amount from 60 to 70 degrees. It is well-defined and is from 1 to 2 feet in width. The ores are copper and gold; the gangue is quartz with considerable admixtures of iron sulphides.

The country consists of felsite breccias underlain by banded rhyolites.

From the upper portion of the reef the average yields were (from concentrated stone) 5 oz. gold per ton, and 14 per cent. copper. At 100 feet these

values had decreased considerably. A crosscourse from 2 to 3 feet in width influenced the reef materially to a distance of some 30 feet on each side. Away from this crosscourse the reef shows marked decrease in values.

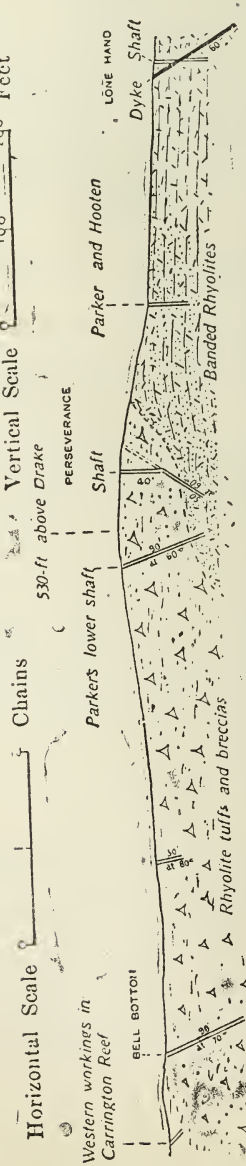
Ground water-level is some 50 feet below the surface, and mining operations were finally suspended owing to the water trouble.

Fig. 16 illustrates the relation of this reef with the Carrington and Perseverance lines.

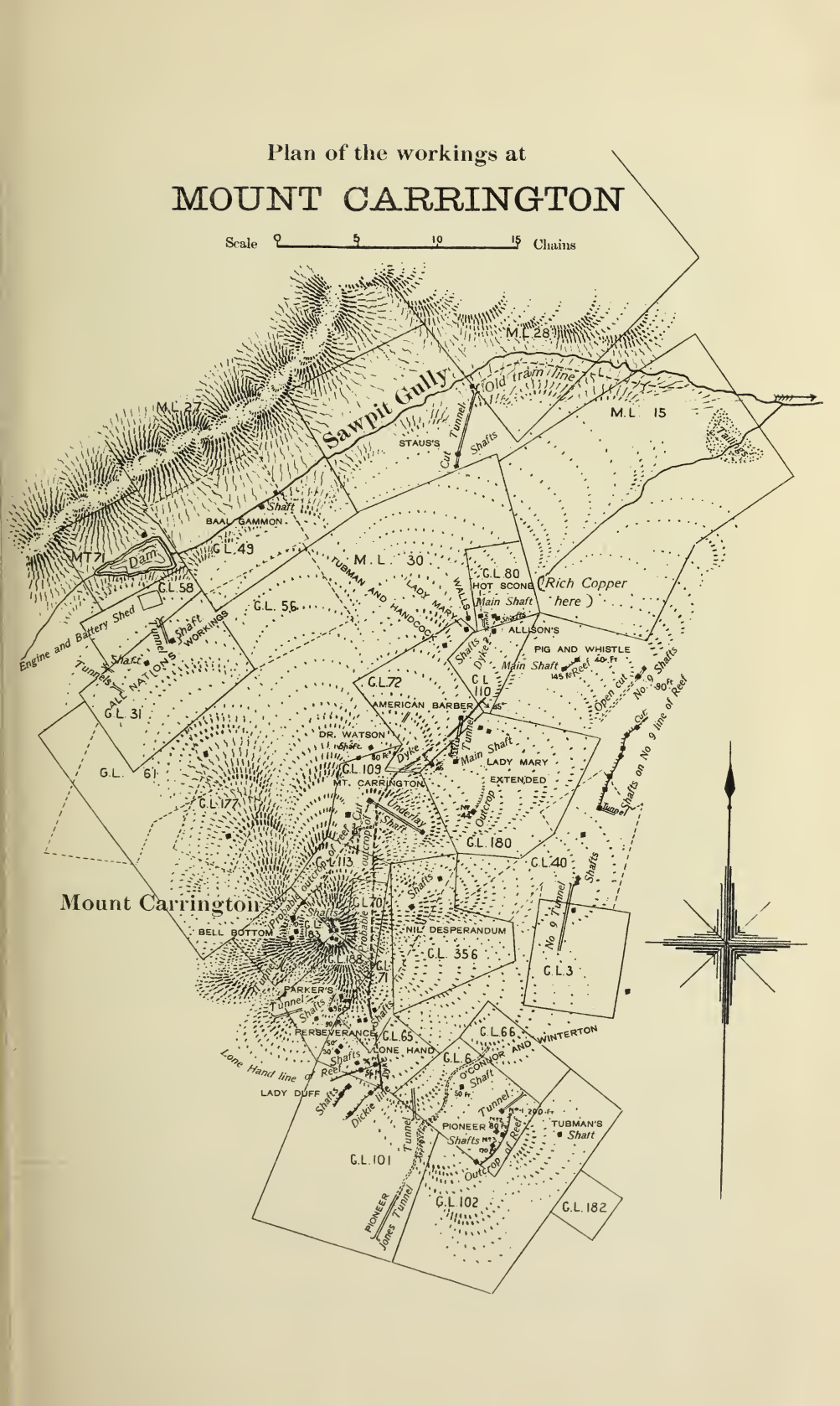
All of them appear to have been determined, in great measure, by the large basic dyke traversing the hill.

Mr. Parker, the owner, is at present driving a low-level tunnel to prove the reef at a depth of 175 feet.

Fig. 16.



Section across Perseverance, Parker's, Bell Bottom, and Carrington lines of reef.


Plan of the workings at
MOUNT CARRINGTON
Scale 0 5 10 15 Chains
M.L. 28
M.L. 27
M.L. 15
Sawpit Gully
Old tram line
STAUS'S
Cut
Tunnel
Shafts
BAAL GAMMON
Shaft
MT7
Dam
G.L. 49
G.L. 58
M.L. 30
TUBMAN AND HANDCOCK
LADY MARY
WALLS
G.L. 80
HOT SCONE
Main Shaft
(Rich Copper here)
G.L. 56
Engine and Battery Shed
Tunnel
Shaft
WORKINGS
ALL NATIONS
G.L. 31
ALLISON'S
PIG AND WHISTLE
Main Shaft
145 ft Reef
40 Ft
Dyke
G.L. 72
AMERICAN BARBER
G.L. 110
45
Open cut
No. 9 Shafts
90 ft
No. 9 line of Reef
DR. WATSON
Shaft
80 ft
Main Shaft
LADY MARY
EXTENDED
G.L. 61
G.L. 109
MT. CARRINGTON
Underlay
Outcrop
G.L. 177
G.L. 180
G.L. 40
Shafts
No. 9 Tunnel
G.L. 113
Mount Carrington
Prohaska Outcrop
Bonanza Outcrop
G.L. 70
BELL BOTTOM
G.L. 168
G.L. 71
NIL DESPERANDUM
G.L. 356
G.L. 3
PARKER'S
Tunnel
Shafts
PERSEVERANCE
G.L. 65
G.L. 66
WINTERTON
CONE HAND
G.L. 6
O'CONNOR
Shaft
Lone Hand line of Reef
LADY DUFF
Dickie line
Tunnel
PIONEER
Shafts
TUBMAN'S
Shaft
G.L. 101
Outcrop of Reef
G.L. 102
G.L. 182
Jones Tunnel

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No. 9.

This is a well-defined line of reef traversing Mount Carrington at a lower level than the Pioneer, Parker's, Perseverance, and Carrington Reefs. The country consists of greyish felsite breccias and tuffs lying just outside of the belt of characteristic Carrington rhyolite breccias.

Prospecting has been carried out by means of some nine or ten shafts, varying from 70 to 100 feet in width. The strike is north-north-west, and the dip westerly at an average amount of 60°.

The ore is copper, as amorphous glance and rich cupriferous pyrites.

The gangue appears to be a *highly* pyritic quartz.

From the very limited observations possible during my visit, the reef appears to be of considerable size and importance, and, excepting the important Adeline Reef, is probably one of the most promising lines should a smelting campaign be undertaken.

Parallel with this line, and at but a very short distance from it, another strongly marked reef occurs carrying copper and lead.

Heavy zinc admixtures, however, occur throughout the ore as carbonates and sulphides.

Attention may here be directed to the fact that a highly mineralised belt of country exists, both at the Lady Mary and Lady Mary Extended, and in the immediate surroundings to the north and north-west. The No. 9, the Pioneer, the Hot Scone, Parker's, and other reefs are here so closely associated,—they have produced so much ore, and withal do not appear to have been tested to any but insignificant depths, that another vigorous prospecting claim would be fully justified. A reverberatory furnace could be used in conjunction with such mining operations.

Kelly's Block.

This is the belt of rhyolite breccias (of types similar to characteristic White Rock and Mount Carrington breccias) covered by M.L. 41.

The ore bodies are contained in a network of colloid quartz-veins, which same do not, apparently, extend into the younger neighbouring volcanic series. The ores are native silver and silver sulphides.

The upper portions only of the mass have been worked, but these have yielded rich returns up to date.

Other properties.

(1) A number of other fairly well defined lines of reef occur on Mount Carrington.* Prospecting operations have been conducted by means of shafts varying from 70 feet to 100 feet in depth, and by crosscuts put in at various levels.

Such are the Nil Desperandum, Baalgammon, Hot Scone, Lone Hand, Lady Duff, Tubman's, Parker and Horton's, (a gold-quartz-vein, half to three quarters of an inch in width, carrying from 17 oz. to 19 oz. of gold per ton; it appears to belong to the older volcanic period), and other lines.

The reefs belong to both periods of ore formation. Copper and gold are the ores mined for.

* The Lead Block is another line near Drake at which considerable work has been done.

(2) *Outside Drake proper.**

(*a*) *Boorook.*

The country consists of fossiliferous marine slates, tuffs, and older volcanics. The ores are silver-minerals. Exploitation was carried on by means of a shaft 320 feet deep. Oxidised ores were met with to a depth of 80 feet from the surface. Below that sulphides were encountered. At this juncture furnaces and other appliances for the proper extraction of the metal were erected by an experienced metallurgist, and successful extraction was accomplished for a considerable period.

At the 150 feet level a large bunch of sulphide ore was met with, some 19 feet wide in the widest portion, and averaging 40 oz. of silver per ton. At the 300 feet level a similar bunch was met with. When this pocket was worked out the mine was abandoned.

Red Rock Mine.†

The ore-bearing deposits at the locality of this name occur in volcanic breccias very similar to the older Drake types. The distance from the latter place is about 10 miles in a north-westerly direction. From the mine the country breaks precipitously to the Cataract River, some 750 feet below.

The gold-bearing lodes here are numerous, but the ore is low in value, 9 dwt. of gold to the ton being the highest known yield. In the Red Rock Company's mine a large deposit of zinc has been met with at the 100 feet level. The ore (zinc) is of a fair quality, and will concentrate up to 50 or 60 per cent. of metal.

Lunatic Gold-field.

This field has been abandoned for a considerable time. The country consists of fossiliferous slates and tuffs apparently of similar age to the Drake series proper. The reefs evidently belong to the younger system of the district.

The reefs exploited were numerous, and include the Lunatic, Golden Crown, Perseverance, Caledonian, Victoria, Little Victoria, and Martin's Reefs.

The following extract from a previous report‡ by this department, may be taken as a general description of the field:

"*Lunatic.*"

"Upon the southern end of the reef three shafts were sunk about twenty years ago. No bulk crushings were ever made of stone from these shafts, and they have long since fallen in."

In No. 8 claim, about 4 chains north of the last-mentioned shafts, four shafts, each about 100 feet deep, have been sunk, and some driving has been carried out. One of the shafts would seem to be intact. I was informed by Mr. Curran, Mining Registrar, that a small quantity of rich stone was obtained here, and that heavy water was encountered. The claim has been abandoned for nearly twenty years.

Exhibition Claim (Phœnix) is situated immediately north of No. 8 claim. A shaft was sunk to a depth of 150 feet. . . . . At intervals the reef has been proved by shallow shafts between the last-mentioned claim and the prospecting claim, which is situated upon the southern end of the reef.

* For the following notes I am indebted to Mr. J. P. Curran, of Drake, the workings not being accessible.
† For other information, see T. W. E. David, Ann. Rept., Dept. Mines for 1886, pp. 161, 162.
‡ J. B. Jaquet, Ann. Rept. Dept. Mines for 1896, pp. 126-128.

Prospector's Claim.

This is practically the only claim that was worked for any length of time. A main shaft, which is now intact, has been sunk to a depth of 203 feet, and five lesser shafts have been sunk to depths of from 50 to 80 feet. The claim was worked intermittently for seven years, and several hundred tons of ore raised from it. After it had been abandoned for some years it was again taken up by Ashbury and Party, who received Government aid to sink the shaft from 144 to 200 feet. No stoping was ever done by the party, and having exhausted their grant they abandoned the mine, and it has been idle ever since. The reef at the bottom of the shaft was, I am informed, only 3 inches thick.

Conclusion.

The reefs of Drake are very numerous, but possess neither great length nor width. The caps and upper portions in almost every example yield rich values of copper glance, copper pyrites, native silver, silver sulphides, and gold, but apparently decrease markedly in value with increase of depth. Small crosscourses apparently have been decidedly influential in enriching reefs.

The majority of the reefs possess a quartz gangue, containing from 10 to 15 per cent. pyrites. Exceptions are the Adeline and No. 9 lines, which contain considerably larger pyritic percentages. Zinc (as also lead) admixtures are common.

Recovery of gold from the ores by ordinary crushing methods has proved insufficient on this field. Various concentrating schemes for saving copper have been adopted, such as crushing and treatment on Wilfley tables and Frue vanners. In many cases these have also proved unsatisfactory, owing to the exceedingly fine state of division in which the rich sooty copper glance occurs.

When concentrated the ore is forwarded to various smelting companies for treatment. But seeing that a great portion of the rich oxidised and sulphuret masses have already been won, leaving the leaner and more complex pyritic ores, the expense of concentrating, with subsequent carriage to smelting works (about £2 per ton), has proved prohibitive to the great majority of the local miners.

Several attempts at local smelting (as the Adeline and White Rock ventures) have already been made, but without success.

It has been suggested that the erection of a smelter at Drake would cause a revival in mining, and several years since an application was made for a Government smelter. The application was refused.

Ore apparently does not here exist in quantity sufficient to warrant the erection of a water-jacket capable of dealing with from 10,000 to 20,000 tons a year. Ore, however, of fair quality, and sufficient for the continuous feeding of one, or probably two, reverberatories exists, but is scattered over the field in small lenticular reefs. These are held by lessees, whose name is almost legion. With the exception of the Adeline, No. 9, and a couple of smaller lines of reef, the ore is of a very siliceous type. Decided zinc admixtures occur in certain reefs. Fuel, as wood, exists in abundance on the spot, but fluxes, as iron oxides and limestone, would be necessary, and would have to be brought from Black Creek, some 13 miles distant.

It is very probable that were the Drake mines, or even any prominent group of Drake mines, under one ownership, a smelting campaign on a moderate

scale might be carried on successfully, since proper selection of ores could be made. Thus, such a group of mines as the northern extension of the Pioneer, the No. 9, The Lady Mary, The Lady Mary Extended, The Hot Scone, and associated reefs, if under one ownership, should be able to yield a supply of ore sufficient for the needs of a reverberatory furnace. The Adeline also would probably furnish enough ore itself to keep a small reverberatory going.

With regard, however, to the field generally, the multiple interests existent, and the futility of guarantee on the part of holders, whose only capital is their physical strength, must be overcome before a successful solution of the problem of ore treatment can be found.

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APPENDIX A.

THE following extract from a report, dated 6th March, 1899, shows that Mr. J. A. Watt, formerly Geological Surveyor in this State, was aware of the relative ages of the volcanism generally, and the later sedimentation.

Mr. Watt's report was not seen until the present Drake report had been completed.

Report by Mr J. A. Watt.

"With the exception of Mount Carrington, which lies about half a mile to the north-east of the township, the rocks surrounding Drake consist of a bedded series of volcanic tuffs and agglomerates of a felsitic character, with, perhaps, occasional bands of felsite representing ancient lava flows of this rock. Sections of the beds of tuffs and agglomerate are well seen in the road-cutting between Newman's Pinch and the township.

"These beds become finer-grained as they are traced westward from Drake, and at about 4 miles to the west of the town the uppermost beds were found to be fossiliferous, containing casts of marine shells and corals in abundance.

"Mount Carrington, which stands at an elevation of about 500 feet above the town of Drake, seems to consist largely of solid felsitic material, which is intersected in all directions by veins of quartz, some of which are gold and copper bearing. Other parts of the mount consist of felsitic fragmentary material in which, in one place, viz., at the All Nation's Mine, rounded masses of felsite are found embedded in a ground mass of the same material.

"All the evidence would seem to point to Mount Carrington as having been one of the centres of eruption, from which the volcanic materials forming the surrounding beds of tuff and agglomerate were ejected. It would, therefore, represent the stump of an ancient volcano."

APPENDIX B.

As shown in the sections facing p. 10, the Warwick series has been intensely folded and faulted. Some observers may find the origin of such intense action in the intrusion of the sediments by the "Tin-Granite." The granite, however, is distant some 10 or 12 miles, and can have had but little influence in mashing the Permo-Carboniferous strata.

It may again be thought that the Warwick crumpling has been more pronounced than that to which the neighbouring Drake sediments has been subjected, and that therefore the former are the older. It must be remembered, however, that the intense crumpling at Warwick has been revealed only by the railway cutting operations, and that in ordinary outcrops the Drake and Warwick areas appear very similar as regards the degree of folding attained by the sediments.

If, however, as the fossil evidence multiplies, it be still found that the Warwick and neighbouring areas are essentially of age not greater than Lower Marine, then we have to record the highly interesting fact that a "critical period," with all its wonderful accompaniment of repeated plutonic intrusions, occurred at the close of the Palæozoic for New England and still more northern areas, while unaffecting Maitland and other neighbouring southern districts.

The fossils found up to the present certainly do not form as complete a set as might be wished, yet they point, undoubtedly, either to a Lower Marine age for the strata, or "a mingling of Lower Marine with slightly older types."—(W. S. Dun.)

Since that period, Eastern Australia appears to have gradually developed into a geographical unit, in which state it has remained during, practically, the whole of tertiary and Post-Tertiary time.

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DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. F. PITTMAN, A.R.S.M., Government Geologist

MINERAL RESOURCES
No. 13.

THE FORBES-PARKES GOLD-FIELD.

BY

E. C. ANDREWS, B.A., F.G.S.,
GEOLOGICAL SURVEYOR.

1910.

SYDNEY: W. A. GULLICK, GOVERNMENT PRINTER.
1910.
[2s.]

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Department of Mines,
Sir, 26 October, 1910.

I have the honor to transmit for publication a report on the Forbes-Parkes Gold-field, by Mr. E. C. Andrews, B.A., Geological Surveyor.

The history of this gold-field is essentially one of variable fortune. In the year 1862 a large population was attracted to Forbes, owing to the discovery there of rich leads of alluvial gold. Four months after the beginning of the rush there were 28,000 persons encamped on the site of the present township, and during the first year's operations upwards of 235,000 oz. of gold were recovered. Owing, however, to the difficulty of following the leads into the deep ground, by reason of the large bodies of water met with, the population, as well as the yield of gold, rapidly decreased in the following year. Between 1862 and 1864 some valuable auriferous reefs were worked at Parkes, and in the year 1871 rich alluvial leads were discovered in that neighbourhood, and were subsequently worked with great success. After a long period of inaction, mining at Forbes was revived in 1896 by the opening of the celebrated Lachlan Mines, in which payable reefs were worked for some years; but although work is still carried on in the Forbes-Parkes Gold-field in a desultory kind of way, it must be admitted that the industry has been at a very low ebb since 1907.

It was with a view of stimulating prospecting on the old gold-field that Mr. Andrews was deputed to make a geological survey of the auriferous area, and place on record an historical account of the progress of mining there, and it is confidently hoped that his efforts will have the desired result.

I have the honor to be,

Sir,

Your obedient Servant,

EDWARD F. PITTMAN,

Government Geologist

The Honorable Alfred Edden, Esq., Minister for Mines.

252365

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II.—INTRODUCTION.

Forbes and Parkes have both been very important gold-fields, but the mining industry in these localities is now at a very low ebb. Almost every "lead" has been abandoned and every mine of importance is lying idle. As a result of this mining inactivity the whole workings are practically inaccessible to one conducting an ordinary geological survey at the present time. The chapters in this report devoted to the discussion on mining geology, and to the descriptions of mining properties, have, on that account, been based partly upon the information obtained from an examination of the general geological features and the mining "tips"; partly also upon a perusal of the various official records [such as the Annual Reports of the Department of Mines, the Geological Records, the Mining Records, the Prospecting Board Papers, "The Industrial Progress of New South Wales, 1870," "Mines and Mineral Statistics, 1875," "The Mineral Products of New South Wales, 1887"], and partly, also, upon conversations with miners, mining engineers, and the Government Inspectors of Mines.

The accompanying report contains a general history of gold-mining in the Forbes-Parkes area, a description also of the physical geography, the general as well as the mining geology, and the methods adopted in working the numerous leads and quartz reefs.

Much greater prominence has been given to the history of this field than is customary in such reports. Emphasis has thus been laid on the fluctuating character of the mining, and a pessimistic view of it may possibly be avoided by a perusal of this chapter.

An area of about 500 square miles has been examined, a map of which has been prepared on a scale of an inch to the mile. Sections representing the Writer's interpretation of the geology of this field also accompany the report. Upon the map are indicated the approximate boundaries of the alluvium, the sedimentary rocks and the igneous rocks. The courses of the lodes and the "leads" are also indicated.

In a field such as the one under consideration, where the area of rock outcrops is relatively insignificant as compared with that of the associated alluvium and waste sheets, and where, moreover, the rock outcrops themselves are rather of the nature of low hills of gentle slope than of bold and rugged escarpments, it becomes a difficult matter to piece together the isolated scraps of information thus obtained, and to produce a connected story of the

geological events which have taken place in such an area. In attempting to map in the boundaries of the alluvium it was found that there had been several fluctuations of level in the river alluvium, and that one of the earlier terraces had been so dismantled as to appear in places merely as a gently sloping cloak of waste. On the map only the present alluvium boundaries have been indicated.

Nevertheless, even with these imperfect data, enough information has been collected to enable the boundaries of the various geological systems to be traced with a fair claim to accuracy. The area so mapped should form a starting point from which to make a general geological map of the whole of the Lachlan Gold-field.

I desire here to cordially thank Mr. J. Medlyn and Mr. Haselhurst, of Parkes, Mr. R. J. Barton, Mr. W. Hasemer, and Mr. Eddy, of Forbes, and Mr. R. M. Alexander, of Tichborne, for placing at my disposal much valuable information concerning the early history and the condition of mining of the field. I desire also to thank the managers and proprietors of the various mines both for general information received and for the use of mining plans and sections.

The maps and sections accompanying the report have been prepared by Mr. C. E. Murton, Field Assistant, under the superintendence of Mr. O. Trickett, L.S. I desire also to thank Mr. Murton for his cordial co-operation in the work. To him is due both the recognition of the Silurian conglomerate in the field and the securing of the greater portion of the collection of the Silurian fossils obtained in the area under consideration.

III.—HISTORY.

It will be advisable at the outset to indicate the relationship which the Forbes "gold rush" bears to the development of mining in Australia, seeing that the "rush" under consideration was but one only of a series which occurred both in New England and in southern New South Wales during the period extending from the years 1860 to 1870.

Stimulated by the sensational discoveries of gold on the Ovens and Mitta Mitta Rivers, the mining community explored the rough ranges at the heads of the Murray, Snowy, and Murrumbidgee Rivers. As a result alluvial gold was found at Kiandra in November, 1859, and from all directions miners then swarmed into this abode of wind and snow, even facing in their mad thirst for the precious metal the hardships of the Upper Murray route from Victoria. But, disappointed by the limited extent of the payable ground, and disheartened by the severity of the plateau winter, the greater number of the miners soon deserted the field, and shortly after their dispersal the rich alluvial deposits of Young (Lambing Flat) were worked. A population of 20,000* camped on the ground during 1861. Each miner, excited by the rapidity with which new fields were being discovered, sought to secure the richest wash dirt rapidly, always holding himself the while in readiness for a fresh "rush." When the news of the gold discovery at Forbes was announced, in the latter end of the same year, a great stream of men set towards that locality, and within three months 28,000 men were on the ground. 300,000 oz. of gold were won within two years, and then, hearing of the gold of the Shotover River in New Zealand in 1863, the miners passed away to this new Eldorado, leaving Forbes almost deserted.

* Pittman, E. F., Mineral Resources of N. S. Wales, p. 62.

Such are the main outlines of the history of gold mining in Australia at the commencement of the sixties—a history in which Forbes played no inconsiderable part.

Prior to 1861 the site of the Forbes township was occupied by a sheep run owned by Mr. T. Ranken.* In June of that year alluvial gold appears to have been found by Josiah Strickland about 50 or 60 yards above Fogarty's Hotel, as a result of intelligent prospecting. A new-comer named German Harry located the South Lead during the latter part of the year 1861. The lead was traced to the North Hill, and there called the North Lead, while its continuation to the Lachlan River was known as the South Lead. Upon the latter 82 claims had consecutively struck payable gold, the depth of the ground worked varying from 110 to 150 feet progressively, while, simultaneously with this, two or three irregular and patchy leads were traced from the South Lead towards the Britannia Reef. As early as 1861 the latter reef had been opened up to some extent by a miner named Sam Lewis, so that alluvial and reef gold had been found almost simultaneously.

In the days of the Gold Commissioners an area of ground 40 feet square only, per party of four, was allowed. This hampered the men in their prospecting operations, as will be seen later.

The area occupied by the alluvial gold of Forbes was not large; but so rich were the claims that an enormous "rush" set in to the place, and various observers estimate the number of miners on the field towards the close of 1861 as from 28,000 to 40,000 souls. According to Warden Dalton† it is possible that not more than "one-sixth of the people were actually occupied in mining operations. The remainder was made up of speculators, traders, mechanics, professional men, women and children, and camp followers, amongst whom the criminal classes were well represented." So dense was the crowd of miners washing pay dirt on the present site of the Forbes township that, according to Mr. R. J. Barton, one of the earliest arrivals, a walk along the position now occupied by Rankine-street could not be made under an hour's time. But as the ground was worked, the greater number of the men deserted the field. By Christmas Day, 1862, the population had been reduced to 12,000—the amount of gold transmitted during that year to the Mint by escort was estimated at 235,044 oz.—and by June, 1863, the population had dwindled to 3,500 souls, and the amount of gold won during the half-year was 50,819 oz. At this juncture the Shotover Gold-field was discovered, and Forbes then became practically deserted.

Naturally in such a limited area as that to which the payable gold of Forbes was restricted there were more disappointed than successful miners. Indeed, for every lucky "digger" there were ten who found nothing. [The Kiandra field had been still more disappointing in this respect.]

Very good order was maintained, considering the opportunities existing for evil-doing in such a large mining camp, as well as the fact that fewer than fifty police were stationed in the district. Robberies were of fairly frequent occurrence, but no horrifying punishments resulted, as at the mining camps in North America. It may be interesting here to note that at Kiandra a peculiar form of punishment attended convictions for minor

† Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 76.

thefts, the culprits having their heads closely shaved.* At Forbes, certain reprehensible practices also were tolerated as affording an outlet for energies which might otherwise have been directed against the well-being of the community. Thus, where the Town Hall now stands, three or four parties would form a ring and win the money of the miners by various well-known tricks.

But of the elemental virtues possessed by the true miner not enough appears to have been made known. The story of the winning of the gold from the deep wet ground of the South, the Victoria and the Caledonian Leads, is one of absolute courage and determination: a story which helps to make history. Living under conditions of almost untold discomfort, menaced by unhygienic surroundings, they toiled on, taking all extremes with the same cheerful spirit. Limited in area to blocks forty feet square for each party of four, unable to erect powerful pumping machinery on the ground, forced to carry unwieldy and water-tight boxes through deep and water-logged drift (sometimes unaided by divers) so as to reach the deeper ground, forced to work waist-deep in water often, constantly in danger of being drowned, crushed or smothered, these men showed themselves resourceful to the last degree. Under such conditions were the richest portions of the main gutters won, the payable wash on the "rim rock," "reef rock" or "high bar" being neglected in the early days of the field, for men who knew that richer ground lay in front of them would not willingly lose time in bad ground in sending much poorer stuff to the surface. Single-handed, they knew they could not cope with the water and running ground; thus, when two parties were approaching each other along the "gutter," each hastened to work out the rich central ground, and then to vacate the claim so worked, preferring to leave the poorer "reef-wash" untouched to working it under almost impossible conditions.

The Victoria and Union Leads were opened up shortly after the discovery of the South Lead, and the King's, the Queen's and the Caledonian Leads a little later again. The Thompson, Mathieson and Bald Hill Leads were not known until a few years later.

A quotation from a report† of Mr. Warden Dalton, upon the early history of Forbes and Parkes is here reproduced, as it shows the manner in which the Parkes Gold-field was found. "During the year 1862 the gold-fields round Forbes had by degrees extended northwards to the Strickland Reefs, and within five miles of the Goobang Creek. As the main leads at Forbes now began to manifest signs of exhaustion, prospecting parties spread in advance of the occupied leads and mines, chiefly northerly. Amongst these were James Pugh and two others, who, crossing the Goobang in August of that year, during the ensuing October, discovered the Pioneer Reef, situated on a ridge about 10 miles distant from the nearest payable mines . . . a trial crushing of one ton of picked stone from the Pioneer produced 10 oz. 17 dwt. of gold. It was said to be payable. A rush ensued, and the result was the opening of several payable quartz reefs, payable from the grass. These reefs were occupied in quick succession, and were proved to be very rich near the surface, becoming less auriferous as they descended; and finally in the years 1866 and 1867 they ceased to be worked with profit, and were abandoned, when the miners removed to other gold-fields, and all trace of mining industry was gradually effaced.

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* *Sydney Morning Herald*, 5th April, 1860.

† Report of 28th June, 1880.—Enclosures to N. S. Wales Parl. Papers, No. 10, 1881.

In the absence of reliable returns I estimate the quantity of gold won on the Billabong Gold-field, from the various quartz reefs, between October, 1862, and December, 1867, at about 40,000 oz."

The early history of these leads has been briefly described by Mr. E. F. Pittman, A.R.S.M., Government Geologist, and an extract from his description * is here reproduced :—" None of the *leads* were traced to their termination, owing to the difficulty of dealing with the water, and the fact that the small areas which were tenable under miners' rights did not warrant sufficient capital to provide proper machinery. To the north-west of the town of Forbes a shaft was put down to a depth of nearly 400 feet in very waterworn pliocene drift, but was not bottomed, and, consequently, this *lead* (the North Lead) was not tested where the indications were, perhaps, the most favourable. The size of the claims held on the alluvial *leads* was only 40 feet x 40 feet, and it is recorded that a party of six men worked out one of these claims on the South Lead in two months, during which period they won 1,900 oz. of gold. It is well known that in those days, when miners were always ready to start off for the scene of the latest (and, therefore, the most attractive) *rush*, the work, especially in deep *leads*, was hurriedly and imperfectly performed, and there is good reason for believing that in such gold-fields as Forbes the washdirt was in many instances only extracted from the main channels, leaving the side, or *reef wash*, as well as that from the junctions of smaller tributaries, untouched. With the aid of suitable appliances, therefore, it is probable that much of the old ground would pay to work again. Quite a number of *leads* which have only been partially worked occur in this gold-field, and there can be little doubt that if they were developed further down their courses they would be found to junction with others not yet discovered."

The following extracts from the *Sydney Morning Herald* during the years 1860–1863, throw light upon the early mining conditions at both Forbes and Parkes :—

The diggings of the Western District have remained during the past month in their usual steady position, if we except a rush made upon Rankin's Station on the Lachlan River. Several large nuggets were found on a flat. . . . The result was a rush, in which great numbers from Lambing Flat joined. Recent intelligence, however, informs us that it has proved a perfect failure, and that all the Lambing Flat men have returned. [July 20, 1861.]

One party sank a shaft 106 feet deep, and then came to 2 feet of washing stuff, and after washing twenty-three buckets of stuff they obtained 5 oz. 13 dwt. of gold. [September 6, 1861.]

One nugget weighing 11 oz. [September 17, 1861.]

There are 700 or 800 men at work there at the present time, who all seem in high spirits. [October 19, 1861.]

A person named Strickland had 32 ozs. of gold taken out of his tent at night while the inmates were asleep. [October 26, 1861.]

A lead has been struck, 180 feet wide, and it is now opened half-a-mile long ; a hole was bottomed to-day, and a 1 lb. weight of gold was washed out of two tubs. [November 2, 1861.]

From the first discovery of this field, it attracted to the place more than ordinary importance, from the indication of a deep lead, the existence of which . . . . would give to the field a character of permanence and comparative certainty in the operations hitherto, one may say, unknown in this colony, although such leads have formed one of the main features of the principal fields in Victoria. . . . The yield from the payable shafts has ranged from half-an-ounce to 8 oz. in the tub. . . . It is the only one (the South lead at Forbes, E.C.A.) in this colony, I believe, which has found favour with the miners from the superior fields of Victoria. [Extract from Commissioner Maclean's report, November 14, 1861.]

* Mineral Resources N. S. Wales. 1901. Pp. 10 and 11.

Some are so enthusiastic that they believe it will be a second Ballarat. . . . In one instance 82 oz. were obtained out of three tubs of wash. [November 16, 1861.[

The success met with on the Lachlan will naturally excite attention to a most promising district. For many years I have anticipated this success; for, as you will find by reference to the instructions received in 1851, in which were embodied the names of districts I had indicated to the Government beforehand, I pointed out the region, the Meridian Ranges, between 32° and 34° south latitude, and 146° and 149° east longitude, as deserving a search for gold. . . . [Extract from report of Rev. W. B. Clarke, November 16, 1861.]

The second lead, named the Victoria, is on the block system. [November 21, 1861.]

The price of gold is reduced from £3 15s. to £3 11s. per oz. [November 26, 1861.]

The lead at the northern end has been lost . . . Great number of shaft failures. Population estimated at 9,000. [November 28, 1861.]

Immense excitement and dismay was created here at the beginning of the month by the sudden loss of the lead. . . . At first everyone was in despair, and the commissioners for a time dreaded the effect that the news would have on the excitable minds of the miners. Luckily, however, before matters came to the worst, it was picked up at the southern end [December 21, 1861.]

The Britannia Quartz Reef Company have been granted a prospecting claim. . . The loose surface soil is impregnated with gold. [December 27, 1861.]

The escort leaves this morning with 11,400 oz. This in reality only represents one week's amount, as upwards of 5,000 oz. of gold and £5,000 cash are left in the camp, the escort boxes not being large enough to contain the whole. [March 18, 1862.]

A nugget weighing 117 oz. has been found on the South Lead. [April 8, 1862.]

The Homeward Bound Claim, South Lead, commenced washing yesterday. Fifty loads of dirt produced 45 lb. of gold. [June 9, 1862.]

A rush has taken place to Billabong, about 20 miles distant [Parkes, E.C.A.], where a rich quartz reef has been found. [November 8, 1862.]

From the Billabong Reefs a few samples have been crushed at Bell's machine, with following result:—2 tons from the Homeward Bound gave 4 oz 8½ dwt., and a similar quantity from the Pioneer 4½ oz. [January 15, 1863.]

The Billabong Reefs are turning out good stone, and in the course of another month or two we may expect to hear of at least three crushing machines at work there. [February 3, 1863.]

Heavy machinery is on the road for the Billabong Reefs. [February 18, 1863.]

In the early days of the district, namely, the years 1862, 1863 and 1864, the Billabong or Parkes Field was noted for its quartz lodes. These were the Pioneer (1862), the Day-spring (1863), the Bushman, the Golden Bar (1863), the Welcome, the Black Snake, Steel's, Strickland's and the associated lodes. Near the surface the values were from 2 to 3 oz. of gold to the ton of stone; but at depths of from 150 to 180 feet the lodes were temporarily abandoned, the miners considering them unpayable at these depths.

From 1867 to 1871 the gold-mining industry at Forbes and Parkes was at a low ebb; the old village of Currajong on the Parkes Field contained only three or four houses, and the crushing plants had all been removed with one exception. About the close of the year 1871, however, a party of prospectors found the No Mistake Lead, an old buried stream channel, distant about 4 miles north-west of the present town of Parkes. Within twelve months the Bushman, Welcome, Great Northern and other rich gold-bearing leads were not only being worked but were paying well. The town of Bushman was formed at this time, and its population within a remarkably short space of time had increased to 6,000 souls. Two years later it had increased to 8,000, and the name of the town was altered from Bushman to Parkes, in honor of the great Australian statesman of that name. The quantity of gold won from the Parkes alluvial workings during the period 1871–1873 is estimated at 50,000 oz.

It was only to be expected that this great success of alluvial mining should be accompanied by a determined search for lodes from which the alluvial gold had been shed. But with this enterprise the inevitable speculators and mining "boomsters" were associated, until it became difficult to distinguish

between genuine and false mining ventures. During the year 1872 the mania for "floating" mines is said to have been at its height*. Nevertheless during the whole of this time the work of alluvial prospecting was progressing, and in 1872 the main Welcome Lead was discovered, its tributary, the Tearaway, being found the following year. This tributary lead it was which was famed for its large "nuggets." In 1874 individual nuggets were recorded, as much as 7, 25, 35, 37 and 134 oz. in weight, while as late as 1876 pieces weighing as much as 30 oz. were still being unearthed.

The year 1874, however, marked a still brighter stage in the history of gold mining in the Parkes District. The mining community, disappointed in its endeavours to trace the Welcome, the Great Northern, and other leads across the Billabong or Goobang Creek, began to look round for other and more promising fields. At this time the fame of the Palmer Gold-field, in North Queensland, spread like wildfire, and the mining settlement of Parkes, among others, supplied the new and distant field with many of its best men, and the population dwindled to about 500 souls. This loss to the Parkes population was, however, only temporary, for on the 8th March, 1874, M'Guiggan and party obtained good prospects from a shaft 45 feet deep in the alluvium and distant about five miles south-west of the present town of Parkes. This find was the commencement of the famous M'Guiggan's Lead, perhaps the most important discovery made on the Billabong Gold-field, not only on account of its own intrinsic value, but also because it was the signal for the magnificent prospecting campaign which was to result in the rapid discovery of the group of leads known as the London, the Ben Nevis, the Tichborne, the Fairy and the Wapping Butcher. Men returned in great numbers from the Palmer and other fields, and within three months after the discovery of the M'Guiggan Lead the district had a population exceeding 10,000 people. The vivid description by Mr. Warden Dalton of the excitement caused by the successful prospecting of the alluvial plain at Tichborne during this period is here reproduced:—

" . . . . hundreds of shepherds followed, who occupied long lines of imaginary leads in anticipation of the red flag. Land speculators also followed like sharks in their wake, and suddenly discovered that a waterless country that had been permitted to lie unoccupied by permanent settlers . . . was the only place where they could erect homesteads. . . . The swinging of base lines was incessant, and no little confusion and litigation was the result. In fact, the operations of the miners on these wide levels appeared more like the evolutions of an army in the field than anything else. Marking claims had resolved itself into a game of chess." †

To the accompaniment of such doings, the leads were located one by one. The Ben Nevis was discovered during the same month as the M'Guiggan Lead, and the London Lead was found a month later, while the group known as the Fairy, the Tichborne, and the Wapping Butcher Leads were first worked in November of the same year. The names of these leads recall to mind the well-known "Tichborne Case," which was occupying the minds of men at that time. With the opening of these alluvial deposits, the town of Tichborne sprang full-grown into being near by, and so important were the finds considered to be, that the Australian Joint Stock and Commercial Banks, as well as the Bank of New South Wales, each opened "branches" at the new town, exclusively for the purchase of gold. Great numbers of energetic men also came to Parkes, and the old straggling

* Margules, Ann. Rept. Dep. Mines N. S. Wales for 1876, p. 89.
† Mines and Mineral Statistics, 1875, p. 31.

mining village was rapidly transformed into an attractive and prosperous town. Many of the yields from these buried stream channels were remarkable, and some of the gutters produced many large nuggets. The ground worked varied from a few feet to 200 feet in depth. The wash varied from one foot to 16 feet in thickness, and its width at times exceeded 200 feet, while the general expenses attached to raising and treating the wash averaged ten shillings per load. The following returns have been selected from the Annual Reports of the Warden and the Mining Registrar for the years 1875 and 1876. Thus, in the year 1876 the three prospecting claims on the M'Guiggan's Lead produced the following returns :—

			Oz. gold.
(1)	M'Guiggan's	3,567 loads for	2,140
(2)	M'Gee's	1,372 ,,	1,372
(3)	Cook's	3,250 ,,	1,950
	Total.....	8,189	5,300

On the Tichborne one party of four won 1,700 oz. of gold during 1875. The Frenchman's block had wash 17 feet thick, and four men realised £5,000 from the treatment of 5,000 loads.

On the Wapping Butcher, one claim 10 chains square and worked by a party of four yielded 1,050 oz. of gold. Four others from an adjoining claim raised £4,000 worth of gold during the same period. An adjoining small claim gave 2,707 oz. from the cleaning up of 1,005 loads of dirt, "Carroll and party, with 1,200 loads, yielded 1,600 oz, amongst which were many nuggets from 2 dwt. up to 18 oz., several 5 and 7 oz. in weight. Farrell and party, 2,200 loads, with a yield of 1,543 oz., many nuggets mostly weighing 5 and 6 oz., the largest being 16 oz. 10 dwt. Messrs. Barlow and party, 600 loads, 450 oz., and from cement 84 oz., making 534 oz. in all. Messrs. Jones and party have already washed 1,306 loads, yielding 2,912 oz. 12 dwt., and had several nuggets of various weights. This party has about 1,000 loads to grass waiting for water to puddle. Messrs. Murphy and party had a large amount of dirt, some yielding 2 oz. to the load; also cement with fine results and nuggets up to 20 oz." *

"Harrison's claim (Fairy Lead, E.C.A.), yielded† 695 oz. to 1,400 loads; amongst the gold was the nugget, now at the Department of Mines, weighing 19 oz. 12 dwt. Barnett and party had 1,070 oz. to 1,390 loads, showing several specimens, one weighing 16 oz."

In passing it may be noted that the Bald Hill Lead at Forbes was opened up at the same time that these wonderful yields were being obtained at Parkes and Tichborne.

Great difficulty was experienced by the miners in tracing the leads as they approached the course of the Billabong Creek. It will be seen by a reference to the general map that the majority of the main leads have been traced almost or quite as far as the Billabong Creek, but with the notable exceptions of the Wapping Butcher, Tichborne and M'Guiggan's South, they almost invariably ceased to be payable as they passed beneath the present creek bed. Indeed, some leads, such as the London and Ben Nevis, ceased to be payable long before reaching the creek. It was ascertained also that the channels were wider and less well defined as they were followed down stream, and that their bottoms partook more of the nature

* Margules' Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 87.
† *Ibid.*, p. 87.

of "gilgais," the gold contents being found rather on the tops of the "gilgais" than in the basins. This is the testimony of the miners themselves. The South Lead also at Forbes was unproductive, as soon as it had passed vertically beneath the Lachlan River, while the Victoria and Caledonian Leads failed to pay before they reached the main stream channel. Large sums of money, however, were spent in attempting both to trace the channels of these leads and to prove them payable, as they approached the main drainage line of the locality.

For a period of almost 16 years the leads of Forbes had lain idle, while the mining timbers and workings gradually fell more and more into a state of disrepair. Nevertheless, it was believed that the richest portions only of the Forbes Leads had been worked out in the early days, and Mr. Warden Dalton* and Mr. Phillip Davies† called attention both to this fact and also to the necessity for examination of the "rim rock" (sides of the channel), in the hope of finding payable gold there. Mr. Davies showed how the "alluvial" of Forbes, particularly that of the South Lead, had been only partially worked for many thousands of feet during the years 1862-1864; how, owing to the great amount of wet drift, the miners had been unable to cope with the difficulties attendant on mining at a depth of 200 feet below the main water channel of the district, by reason of the disabilities they laboured under, especially in connection with the small area (40 feet square) allowed to each claim by law in the early days. In addition to this, attention was drawn by him to the fact that while money was being spent freely in "floating" quartz-mines of doubtful value, very little money, comparatively, had been spent on alluvial mining. He also pointed out how reefs had been unearthed by an energetic search for alluvial gold, and he instanced the wonderful history of the Ballarat and Bendigo fields in this connection. One extract‡ from his clearly-worded report is here reproduced:—"Strange to say, just at the time when the alluvial diggings of Parkes were discovered, the great mania in quartz speculations was at its highest pitch of excitement; nevertheless, none of the public companies that were formed in Sydney ever spent a shilling on the alluvial holdings, but it is well known that a number of valueless quartz companies were floated in that district that had not the shadow of a chance of ever paying a dividend. But what was the result as regards the alluvial of the same district? The latter class of mining produced at the rate of from six to eight thousand oz. of gold per month for nearly four years, and afforded immense profit to the individual miner without the outlay of any capital worth mentioning. One little alluvial claim designated the Welshman's, on the Wapping Butcher, produced 3,306 loads of wash dirt, yielding 6,912 oz. 12 dwt., or an average of over 2 oz. per load. The expense attached to the working of the claim, including capital to commence operations, is estimated at 10s. per load, ... but all the quartz companies that were floated in the district, at about £180,000, only paid about £7,000 dividend, and that mostly out of subscribed capital. Yet . . . the capitalists will insist upon speculating in what I call phantom quartz mines."

Mr. Davies then made an effort to work the South Lead himself, and by the close of 1879 he had put down a shaft 250 feet deep, excavated a chamber, driven 300 feet of lower main levels, and put in 1500 feet of drives in the wash dirt. One lot of 900 tons yielded 204 oz. of gold. The water was troublesome, making at the rate of 72,000 gallons a day for nine months. This trial was only partially successful, and in 1880 most of the miners deserted the field and left for Temora, Mount Poole, and Mount M'Donald.

* Ann. Rept. Dept. Mines N. S. Wales for 1877, pp. 74-77. † *Ibid*, pp. 82-84.
‡ Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 86.

The deeper portions of the Parkes leads had also been exploited at this time. The details of these attempts will be found discussed in the chapter dealing with the leads.

Just about the time (1876–1877) when Mr. Warden Dalton and Mr. Phillip Davies were urging the necessity of working the alluvial, so as thereby to unearth any reefs hidden under the overburden of river drift, it was reported that the miners had located reefs at a depth of 90 feet from the surface by sinking on the Bushman Lead of Parkes. These reefs were afterwards to become important producers of gold, but in the meantime very little mining, with the notable exception of the working of the Bonnie Dundee by Medlyn Brothers, appears to have been done either at Parkes or at Forbes between the years 1878 and 1883.

In the early part of 1886 several rushes took place to the large alluvial flat near Tichborne, known as Scrubby Plains. The "Abbott Rush" of June, 1886, was one of these. The gold found in all the scrubby plains leads, however, proved to be very patchy. At the same time the South Lead of Forbes was again taken up, and three companies were formed, whose claims were called the Nil Desperandum, the Forbes Alluvial Gold Mining Company, and the Crinoline. The results, however, attending these ventures were far from encouraging, and the companies just named suspended work about the year 1889.

It will now be necessary to retrace our steps a little, so as to understand the important developments which had been taking place at Parkes during the early part of the period extending from 1880 to 1890. At the same time it illustrates the difficulty under which the miner labours, and the immense hope and courage he must be possessed of when exploiting new ground. Incidentally, also, it throws light on the constant conflict of interests existing between the Lands and Mines Departments, and the difficulty experienced in adjudging the respective claims of the two Departments impartially.

It appears that most of the area containing the Quayle's, the Phœnix, the Gladstone, the Bonnie Dundee, and the associated mines was formerly leased to a public company, which abandoned the land after a trial of the lodes. Many of the inhabitants of Parkes at this stage considered that the best interests of the town would be served by disposing of this old mining site in small private allotments. The Department of Mines, however, retained the land, taking the view that the lodes known to exist under the alluvium had not been sufficiently tested to justify the alienation of the land. The Department of Mines still retaining the land in 1883, a Mr. Haselhurst took up an extended claim, 200 feet by 400 feet, on the line of lode known as the "Buchanan." He sank a shaft 80 feet deep on the Bushman's Lead, and exposed the "Buchanan Reef" in the bottom of the shaft. The stone there, however, was not payable. He then entered an old shaft on the line of lode and drove 38 feet along the lode, but was unsuccessful. Next, by examining the old spoil heaps around he finally obtained some "colours" near the old shaft just mentioned. He concluded that it must have come from an old drive opening out of the shaft in which he had been working. Having proved this supposition to be correct, he found a "leader" only six inches in width, which, however, contained a little gold. He could only drive a short distance in one direction without entering another claim, while at the other end the "leader" had apparently died out. By driving on this, however, he obtained good prospects. From 13 tons of stone he procured 39 oz. of gold. A shoot of payable stone 120 feet in length was then opened up, which yielded splendid results. Up till December, 1887, it had yielded 6,528 oz. of gold from 1,383 tons of stone. In all, about £60,000 worth of gold was obtained from it. In 1890 the mine was sold for £20,000 to the Haselhurst's Proprietary Company.

Another sign of the revival of quartz mining in this district was the erection of two large crushing plants at Parkes during this period.

In the year 1893 another attempt was made to work the South Lead at Forbes, which had been lying idle almost continually for several years. Some good wash-dirt was obtained, but the results were not generally satisfactory. Just before this (1892) the Bushman Reef of Parkes had been again opened up. The mine had been practically abandoned since the work done on it in the early days of the field, and the adjacent land also appears to have been included in that which had been sought at various times for residential purposes, but had been retained by the Department of Mines. A small party of miners during this year (1892) won 774 oz. from 378 tons of stone. In 1893, £5,273 worth of gold was won, and a party of tributors during 1894 recovered 3,972 oz. of gold from 1,558 tons of stone. Between the dates 1892 and 1898 at least 17,382 tons of stone had been treated for a yield of about 18,000 oz. of gold. These returns may be incomplete, for Mr. J. Wann informs me that 25,000 oz. gold were won from the middle levels of the Bushman Lode between the dates 1892 and 1900. By the same authority I am informed that the upper workings along this lode yielded from 25,000 to 30,000 oz. of gold in the early days of the field.

Other lodes such as the Dayspring and the Koh-i-noor were also being worked in Parkes at this time, and during the four years ending 30th December, 1893, the Parkes lodes had yielded £135,563 worth of gold from 37,796 tons of stone. All this and an equally large amount of gold from the Buchanan and related lines had thus been obtained in a short space of time from land which was thought to be useless from the point of view of mining.

It will now be interesting to follow the history of mining at Forbes about this period. After the failure to work the deep leads successfully during the period 1886–1888, no mining operations of importance were carried on for a considerable period of time, but in 1896 another important stage was reached when an ironstone outcrop situated in a large alluvial flat about three miles north of Forbes was prospected for gold. A claim was applied for. Possession was taken on the 25th August, 1896, and a survey of it was made on the 10th October, 1896. This was the start of the famous Lachlan Mines. Gold being found, it was decided to sink on the ironstone. This was done, and with the proceeds obtained as the result of this work the prospectors determined to form a company. The latter was formed in 1897 and called the "Lachlan Gold Fields Company, Ltd." By 1898 about 2,088 oz. of gold had been won, and in 1899 5,613 tons of stone were treated for a return of 4,287 oz of gold. Again in 1902 gold to the value of £22,103 was won, while in 1903 as much as £24,882 worth of gold was recovered. By this time a shaft 500 feet deep had been sunk ; long drives had been run along the vein, and men to the number of 87 were this year in constant employment about the mine.

In 1901 the continuation to the north of the Lachlan Reef was opened up and named the Nil Desperandum. To work it a company was formed with a capital of £6,250. By the close of 1903 a sum of money as large as £15,600 had been expended in opening up this line of lode, and machinery had been erected at an estimated cost of £5,840. The prospects of this mine, however, were never so bright as those of its neighbour to the immediate south. Meanwhile interest was now being centred round the continuation of the same line of lode still farther to the north. The Bald Hill Lead had been traced towards this line of lode years before, and the existence of the lode itself had been predicted by the alluvial miners. The lode was located finally under 35 feet of alluvium, and in May, 1902, the Hauraki Gold

Mining Company was formed to work it. Another company, however (the North Lachlan Gold Mining Company) was formed in 1904. 5,036 tons of stone were treated during this year, for a return of 2,062 oz. gold, exclusive of slime values, while in 1905 the amount of stone treated was 5,825 tons, and the yield of gold from such treatment was 3,786 oz. The value of the machinery erected was £10,500.

Since the year 1907 mining at both Forbes and Parkes has been at a very low ebb. Notwithstanding this stagnation of the mining industry to-day, a careful perusal of the history herewith furnished (and lengthened purposely so as to bring into prominence this intermittent character of the mining) will tend to counteract the pessimistic view existing at present as to the future of the mining industry at Forbes and Parkes. An epitome of the history may make this clearer. First we have the rush to the Forbes alluvial in 1861; the extraction of fully 300,000 oz. of gold from the deep wet leads; the exodus thence to the Shotover (N.Z.) during 1863; the discovery of the Parkes or Billabong reefs in 1862, and the profitable working of the same up till 1864; the apparent failure of these reefs and leads to be productive at depths greater than 200 feet; the departure of the miners for Grenfell in 1867, as well as for the Palmer in the early "seventies." Then we have the discovery of the No Mistake lead in 1871, and that of the Welcome in 1872; then the period of depression in 1873, followed by the grand awakening in 1874 on account of the discovery of the group of leads (of which M'Guiggan's is the type) in an area long supposed to have been exhausted by all but the most sanguine of the mining community. New towns sprang into existence as if by magic, and miners were once more thrown into a state of wild excitement. From the leads of the Parkes-Tichborne district about 200,000 oz. of gold were recovered. Then came the darker days at the close of the "seventies," and during the early part of the "eighties." The early quartz-mining companies of Parkes and Forbes had failed; the people sought to alienate the mining reserve around the Phœnix and the Bushman Mines, but the Department of Mines remained firm, and retained the land in the mining reserve, and in a few years their action was justified by the development of the Haselhurst Lode, one mine along which produced £60,000 worth of gold between the years 1883 and 1892. In 1892 the Bushman Lode was re-opened, and produced even more startling results than had the Bushman Line. The Koh-i-noor and Dayspring also produced splendid results during this period. The last important attempt was made at Forbes in 1896, when the Lachlan line of lode became a consistent and splendid producer of gold. Now, in 1910, men's thoughts are being directed to agricultural pursuits because the mining outlook is so very depressing. The present state of inactivity is not more pronounced, however, than it was in the late "sixties" and the late "seventies." There is a tendency to magnify the present depressed state of mining affairs, and to cast a halo of romance round the early mining days by minimising its failures and remembering only its successes. This is only a necessity of perspective, and may be compared to a view taken of a straight line of telegraph posts, where the observer sees the posts in his vicinity to be well separated, while those in the distance appear to be crowded together. These fields in the early days had their trials, their periods of inactivity, just as acutely felt then as is the one to-day. One cannot say that Parkes and Forbes, as mining fields, will become as important as before, but this one can say, that the auriferous belt has not yet been sufficiently prospected, especially beneath the cover of alluvium, to justify any serious doubt as to its future revival as a successful mining field. Until the known auriferous belt shall

have been thoroughly prospected history here may repeat itself, and the present period of mining depression be followed by the discovery of some lead or lode hitherto unsuspected. Or again, some well known lode may be ascertained to contain a rich shoot of gold hitherto unknown. In any case, with so great a development of alluvium, as yet not completely tested, there is always hope for, and probability of, the discovery of fresh payable lodes.

IV.—GOLD YIELDS FOR PARKES AND FORBES.

Year.	Oz.	Value.	Locality.	Source of Information.
1861	4,151	.....	Forbes only.	
1862	212,547	.. ..	,, ,,	
1863	71,493	.....	....	
1864	18,722	.....	.....	
1865	9,869	.....	.....	
1866	16,503	.....	.....	
1867	7,746	.....	.....	
1868	3,067	.....	.....	
1869	1,583	.....	.....	
1870	...	.....	.....	
1871			Parkes—3 years.	
1872	50,629	....	Forbes, 629 oz.	
1873				
1874	51,161	.....	Parkes & Forbes. (533 oz., Forbes).	
1875	57,851	.....	Parkes & Forbes.	
1876	24,106	.....	Parkes only.	
1877	9,399	.....	,, ,,	
1878	5,147	... .	,, ,,	
1879	4,472	.....	Parkes & Forbes.	
1880	5,006	.....	,, ,,	Mining Registrar's Reports
1881	4,131	.....	,, ,,	,, ,, ,,
1882	3,126	.....	Parkes only	,, ,, ,,
1883	3,000	.....	,, ,,	
1884	3,951	.....	Parkes & Forbes	
1885	7,246	.....	,, ,,	Mining Registrar's Reports
1886	5,731	.....	,, ,,	,, ,, ,,
1887	6,611	.....	,, ,,	,, ,, ,,
1888	5,231	.....	,, ,,	,, ,, ,,
1889	10,544	.. ..	....	Mint Returns
1890	11,547	.....	....	,, ,,
1891	9,695	.....	Forbes almost nil	,, ,,
1892	7,354	.....	.. ..	,, ,,
1893	7,282	.....	.....	,, ,,
1894	9,746	.....	Forbes, about 87 oz.	Mining Registrar and Warden's Reports
1895	10,672	.....	.....	,, ,, ,,
1896	12,514	.....	Forbes, no returns	Mining Registrar's Reports
1897	11,145	.....	Forbes, 28 oz.	Mint Returns
1898	12,694	.....	.....	,, ,,
1899	11,056	.. ..	....	Mining Registrar's Reports
1900	11,298	.....	.....	,, ,, ,,
1901	8,498	.....	.....	,, ,, ,,
1902	7,770	... .	.....	,, ,, ,,
1903	11,580	£46,204	.. ..	
1904	14,913	£60,442	.....	
1905	13,721	£53,114	.....	
1906	10,074	£42,193	.....	
1907	3,329	£12,231	....	
1908	1,756	£6,218	.....	
1909	2,531	£8,771	Forbes, 1,626 oz.	

V.—PHYSICAL GEOGRAPHY.

Parkes is distant 272, and Forbes 292 miles by rail from Sydney, *via* Molong, Forbes being 20 miles south of the sister town. Forbes is 783 feet above sea level, and has an approximate population of 5,000 people, while Parkes is 1,035 feet above the sea, and has a population of about 3,000 souls. The heights here given are those of the respective railway stations, and the populations are those of the municipalities only. Each is the centre of a populous district, wheat and wool growing being the main industries. Originally mining was the main support of both districts, but of recent years the agricultural and pastoral interests have altogether overshadowed those of mining. Last year about 30,000 acres were reported to be under wheat at Forbes, and from 40,000 to 50,000 acres in the Parkes district. The soil is admirably adapted for wheat growing, but the rainfall cannot be depended upon. The amount of rain which falls would doubtless be sufficient if it fell at the proper time, but falling often at the wrong time, and failing to fall altogether during certain irregularly-spaced periods, the land to a great extent still lies in its primitive state. The average rainfall at Forbes is 20·01 inches, and at Parkes is 21·54 inches. The maximum and minimum temperatures respectively for Forbes and Parkes are 118·4° and 24° in the former, and 114·9° and 20° in the latter case. The amount of evaporation during the summer months is enormous, and the dry westerly winds are also great desiccating agents during the whole year.

Two principal classes of soil occur—one, a thick waste sheet of exceedingly gentle slope, often extending from the alluvium proper up to the very summits of the low hills which rise from the plains. This is a brown or red loam, and much sought by the wheat grower. In many places it is almost impossible to distinguish it in mass from the associated but lower alluvial plains by the unaided eye, and frequently when mapping in alluvium one relies on its prevailing brick-red to chocolate colour to distinguish it from the sticky black clay of the associated alluvial plain. Along the Lachlan River the broad mass of true alluvium does not appear to be so well suited for wheat-growing purposes (under the present conditions of farming) as are the gentle waste-sheet slopes.

Vegetation.—The river red-gum (*Eucalyptus rostrata*) frequents the banks of the main watercourses, while the alluvial plain skirting the river is covered with open forest growths of magnificent specimens of Yellow Jacket (*E. melliodora*), Fuzzybox (*E. conica*) and *Acacia decurrens*. On the ridges and in the interstream areas generally one finds Red-gum (*E. tereticornis*), Bimble-box (*E. populifolia*), Narrow-leaved Box (*E. Woollsiana*), White-box (*E. albens*), Brittle Red-gum (*E. dealbata*), She-oak (*Casuarina stricta*) and *Acacia decora*, while on the Gilgai country one commonly finds Yarran (*Acacia homalophylla*), Myall (*Acacia pendula*), Bull-oak (*Casuarina Luehmanni*), White or Red Wood (*Heterodendron olæifolium*). The botany, in brief, is that which characterises the warm dry climate of the central division of the State of New South Wales.

For a more detailed account of the vegetation of this area, the reader is referred to the botanical papers of Mr. R. H. Cambage.*

* Procs. Linn. Soc. N. S. Wales, 1901 ; xxvi, p. 317-333 ; 685-699.

Geographical position.—The Forbes-Parkes district lies neither upon the tableland nor upon the great inland "Black-soil" plain, but occupies a position intermediate to the two, one nearer, however, to the broad and gently sloping plain than to the upland. The average height of the tableland to the east of the subject area slightly exceeds 3,000 feet, while the great "Black-soil plain"* commences near Lake Cudgellico and Narrandera, which lie about 600 feet above sea level. To one approaching Forbes across the mirage-haunted plain of the west it would be seen, as Condobolin were left behind, that the monotonous sweep of plain had suddenly become diversified with islands of rock, and that the plain had sent long broad tongues of alluvium into the ranges, the tongues ever diminishing in size, and the mountains ever crowding more and more closely, the one upon the other, until at some distance west of Forbes they had become welded together to form a high continuous or plateau surface. On the other hand, to one approaching Forbes from the highlands, back of Mt. Macdonald, the plateau would be observed to be deeply trenched at first with a network of gorges which, followed westwards, gradually coalesce to form the mighty valley of the Lachlan, ever broadening with increasing progress westwards. With the approach of the Great Plains the mountain piles would be observed to dwindle in height; to become more and more isolated; their profiles would become more and more gentle; the cloak of waste would be seen clinging to their sides, the alluvium growing wider, and the hills would appear to be buried first to their ankles, then to their knees and their waists, until finally the last knob had disappeared beneath the sea of alluvium.

The main topographical facts of this region, then, are as follows:—

(*a*) A tableland to the east.

(*b*) A "Black-soil," or Piedmont, plain to the west.

(*c*) A dismantled tableland in the intermediate area (that is, Forbes and Parkes) diversified by broad valleys, with deeply alluviated bottoms.

Upon a closer examination, however, it is evident that a multitude of details modify the main topographical features just enumerated.

For instance, it is evident that a long valley exists continuously through from Parkes to Peak Hill, its eastern wall being marked by the steep Harvey and Bumberry Ranges† To the west the long north-and-south quartzite ridge, pierced by the Jemalong, Goobang, and Bogan Gate Gaps, forms a western wall to this valley, which either was tributary to the Lachlan or the Bogan River. Several distinct, although dismantled, rock platforms evidently exist in the lower portions of this valley. Thus, the low and narrow rock bench, about 50 or 75 feet above the Billabong Creek, on which the main town of Parkes is built, and which follows the right hand bank of the creek for some distance below the Molong road crossing, evidently represents portion of a recent valley floor of the Billabong Creek. A view from any of the many minor trigonometrical stations around Forbes and Parkes suggests the idea that all such stations are situated upon remnants of another old valley floor of the Lachlan and its tributary the Billabong Creek, the older floor remnants under consideration being several hundreds of feet higher than the associated stream levels of to-day. One large remnant of this old valley floor is especially well preserved in the neighbourhood of the water-shed of the Bogan River and the Billabong Creek.

* Geographically, such a plain is known as a Piedmont Plain.
† This mountain range marks the line of a recent fault.

While travelling along the road from Parkes to Alectown, one passes for miles over this recent valley floor. The higher ground between Daroobalgie and Tichborne is also a remnant of a former valley floor. All around one may notice traces of a still older floor, while in the neighbourhood of Parkes one has abundant evidence of the existence of an old valley floor intermediate in age between the two just described. Remnants of at least four of these old valley floors may be seen in the neighbourhood of Parkes and the watershed of the Bogan and Billabong watercourses. All, however, are distinctly enclosed by the high and widely-separated quartzitic and granitic walls of the main valley. Above Eugowra again may be seen the remnant of an old valley floor of the Lachlan carved out of granite and lying about 700 feet above the bed of the present main water channel. Nevertheless the casual observer may not recognise these benches as remnants of old valley bottoms, because the effect on them by later stream action has been so marked that fragments only of them remain among the harder rocks, the portions of the valley bases formed of softer rocks having been completely removed. However, one may see that the old rock benches and low flat-topped hills have at one time formed continuous surfaces, and when one examines the Bogan-Billabong watershed one can read even at a glance the story of the repeated formation of valleys, the one under the other. Away from these watersheds, however, the rock outcrops are mainly confined to low hills running North and South for distances as great as 20 miles—this, however, only in exceptional cases.

This is not the complete tale of the formation of valley floors one below the other within the same grand enclosing walls, for the existence of other and lower channels has been revealed by the operations of the alluvial miner. Around Parkes old watercourses are found from 50 to 100 feet below the present surface of the alluvium; near Tichborne itself the old channels lie from 100 to 150 feet below the present surface of the black-soil plain; the famous South lead of Forbes has its channel as far below the surface as 210 feet, while Mr. Warden Dalton, in 1876, reported * "that a channel in the older tertiary drift crosses the richest portion of the gold-field, and at a depth of 330 feet has not been bottomed—that that channel must in ancient times have received the local drainage, and that the leads discovered were in all probability tributary to it."

These deep leads are in turn divisible into a younger and an older group of stream channels. In proof of this the following clear statement of Mr. Warden Dalton may be quoted † :—"The London Lead, about three miles long, but only occupied now and during the past year, at the head is from 35 to 83 feet deep as far as No. 21; below that claim a channel 160 to 170 feet deep crosses the lead, or what may hereafter prove to be the bench workings. This channel has recently been found to contain a poor wash-drift about 8 feet in thickness; whether this is payable has not been ascertained. The existence of this main watercourse has been long known, as it was discovered on the first opening of the lead; it has been also found to cross the Ben Nevis Lead half-a-mile further to the west . . . . On the opposite bank of this deep ground the depth decreases to between 80 and 90 feet . . . ."

The following extracts on the subject of buried valleys are taken from a report of Mr. Margules.‡ "By several shafts it was ascertained that the ground [The Ben Nevis E. C. A.] has sudden descents from 25 feet to 120 feet in less than half-a-mile; then again it ascends as suddenly to less than

* Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 75. † *Ibid.*, 1877, p. 80.
‡ *Ibid.*, 1876, pp. 83 84.

100 feet, and so on, within a very short distance, while a belt of older amygdaloidal basalt, called by the miners "tertiary bottom," crosses the lead from north to south, the Ben Nevis' run of gold being south-east to north-west. . . . ."

" . . . . . Some shallower ground was traced westwards at a depth of about 82 feet, to the left of the shaft 150 feet deep—the wash seemed lodged on a plateau. . . . ."

Evidence of valley levels again exists in the profiles developed in the alluvium itself. For example, the recent alluvium may be well seen about 7 miles west of Forbes, where it is traversed by the Condobolin-road, following the right-hand bank of the Lachlan River. A sudden rise of from 7 to 10 feet brings one into the upper and main mass of the "black soil." In traversing this upper alluvium in turn one frequently finds banks and irregularly-shaped masses of sand and stiff black clay rising from 20 to 25 feet above the general level of the plain. The large sand heap, about 30 acres in extent, on which Raymond's vineyard is situated, is an example. A flat-topped hill of black soil about one mile in length, which occurs about 6 or 7 miles out of Forbes, along the Eugowra-road, is another example. The long and gentle red soil slopes, almost indistinguishable to the unaided eye from the associated black soil plain, are also remnants of this older and upper alluvium. The "gilgai" country also frequently marks one of the dismantled "alluvium" levels.

Such being the main facts of observation, a simple explanation of the phenomena may be advanced. It is well known that when two fragments or masses of earth material are dragged across each other a mutual loss is sustained in volume, the stronger fragment suffering considerably less from the action than the weaker. It will thus be seen that a stream, when armed with a load of stones and sand, must wear away any point of the base of the channel along which it flows so long as it is able to move its load of débris as a whole over the point in question. On the other hand, as soon as it becomes incompetent to move its load, as a whole, over any particular point of its channel base, it becomes unable to cut into it at that point, because some of the material falls out on to the channel base there, instead of being dragged over it, and thus actually protects it. That is to say, in this case it will alluviate or fill up its channel instead of cutting it deeper. Now the latter is exactly what the Lachlan system has been doing in recent geographical times, that is, it has been definitely proved (by mining operations) to possess decided rockbound channels all now buried for several hundreds of feet under the present alluvium. Whichever way we look at the problem we see that a mass of alluvium has been brought downwards by the streams, and that the old channels have been choked up along their lower portions.

When a land surface is elevated, its streams necessarily have a steeper path either to the water basin into which they flow, or on to the plain at the mountain feet, than they had before such elevation took place. It is easily seen, therefore, that this steeper run to the goal will induce in them a greater velocity than heretofore. But because they have at this stage an increased velocity, they also have a greater power of transportation. But we know that when earth material is rolled over other earth material the both cause mutual loss to each other; thus the mass of pebbles and sand rolled along the channel base becomes less and less in size, but in doing so it cuts gutters or channels into the earth's surface. He who would see such cutting of channels should not examine the streams when they are

in the low or drought stage, but should rather study them during the action of violent and protracted rain storms. The important point, however, to notice is this, if streams could make channels or valleys in the old land surface, then, upon a decided elevation of the same land surface they will have even greater power than before; and all other things being equal they will proceed to cut deep and steep sided valleys along their old floors. If the land elevation has been only moderate in amount the streams will gain a moderate increase in power only, and they will cut deeper channels along their old courses; neverthless, not so deep as those cut in the land which has been lifted to a great height.

On the other hand, if the land sinks, then the streams will flow still more slowly, and hence more feebly, than heretofore. Thus the channel bottoms at this stage, instead of being cut away, as heretofore, will be buried under alluvium.

And, again, if a series of volcanic flows should dam the river valleys—say, for example, the Lachlan, below Forbes—then the stream channels would also be filled gradually up in this manner to the level of the uppermost lava flow, just as a dam is gradually filled with débris.

Conversely, if we see valley channels cut out of the floors of other and older valleys, or if we see definite rock-bound channels now occupied by alluvium, we are justified in assuming that in the first case an elevation of that district has taken place which has caused the streams to cut their channels deeper than formerly; and in the second case that subsidence has taken place, or that lava flows have dammed the courses of the streams.

But in the case of the Forbes and Parkes districts there is no evidence to show that the mouths of their draining streams have been dammed in recent times by lava flows, while there is abundant evidence both of elevation and sinking of the land in late and recent geological time. It is highly probable, then, that at a certain period in late geological times the region from Orange to that west of Condobolin was elevated and tilted to the west, and that the Lachlan streams gained greater power thereby, and gradually excavated the mighty Lachlan Valley out of the plateau. At various times this land surface rose slowly, and each time that it did so the streams excavated a valley floor below the previously formed one. Then in much later geological times the land sank, and just as the streams had deepened their channels during elevation, so now upon subsidence they commenced to fill up the bases of their channels with debris brought down from the surrounding hills. At present the Lachlan Valley at Forbes has been filled up with alluvium to the depth of several hundreds of feet. At the close of this sedimentary period the black soil plain around Forbes was at least from 20 to 25 feet deeper than it is at present. At first sight it would appear that a slight rise of the land had taken place after the deposition of the alluvium, and by this means that the streams again had grown somewhat stronger, and that the upper portion of the alluvium had been cut away, leaving only isolated patches, terraces, and broad slopes of alluvium to indicate its former great extent. A simpler explanation, however, is to be found—namely, that the plains were rapidly formed after the formation of the plateau. After the formation of the gorges in the plateau, the streams lost their former strength; hence they now carry along smaller loads, and the old plain is at the present time being cut up by the rivers which formed it.

Prospecting operations show that a fairly coarse drift is often found along the base of the gutters of the leads, while much of the surface material is of stiff black clay; they reveal the fact also that a thick drift occurs (see bore sections, page 36) about 40 feet below the surface at Forbes, and that boulders

and pebbles are scattered throughout the clay and sand layers. A more detailed description of these deposits will be found in the general chapter of the leads.

As for the age of the valley levels and the later alluvium which occupies the bases of the valleys, it can only be surmised by analogy. Valleys in other parts of the world equally large and as far removed from the sea as the Lachlan at Forbes are referable in age to the Pliocene or latest division of the tertiary, while alluvial plains similar to those of the "Black-soil" Plain are referable to the Pleistocene or Recent Period. No certain fossil evidence of age for the lower alluvium exists, but leads at Victoria (such as those of Chiltern) having the same physiographical associations have been proved to be of Pleistocene age. It has therefore been considered advisable to class the deep leads of Parkes and Forbes as of this age. On the other hand the great and apparently uniform layers of coarse drift occurring at a depth of about 40 feet below the present alluvial surface suggests a great revolution in the surrounding topography, whereby layers of sand and clay could suddenly give place to heavy drift layers. The great Black-soil Plain itself, however, for the upper 40 feet of its mass, is decidedly of Pleistocene age; bones of gigantic animals such as the Diprotodon having been found in the upper layers. Thus, at a depth of 18 feet below the present surface, Mr. Hasmer, of Forbes, found these interesting remains in his large brick pit. Associated with them were several "blackfellows' ovens."

VI.—GENERAL GEOLOGY.

A.—Sedimentary Rocks.

The sediments of the Forbes and Parkes districts may be classed provisionally as: Ordovician, Silurian, Devonian, and Pleistocene. Rocks of definite Silurian age occur at Forbes, while the sediments of the associated gold belt appear to be much more highly altered than those of Silurian age. A pre-Silurian or Ordovician age has thus been provisionally assigned to them. In support of this conclusion, the fact may be mentioned that rocks of similar lithological characteristics situated along the same strike as the Forbes–Parkes gold belt occur some little distance to the north at Tomingley, the age of the latter being Ordovician.

Certain quartzite, sandstone and shale beds containing Lepidodendra and other plant remains, as well as fish scales, have been described which are of Devonian age. The "Black-soil" Plains are here referred to the Pleistocene period.

Very little definite information has been obtained concerning the rocks of the district. They occur as inliers sporadically distributed throughout a sea of alluvium, and the outcrops of the rocks themselves are frequently cloaked over with thick waste sheets. The literature also of the general geology of the Forbes-Parkes district is very scanty. In 1885 * Mr. C. S. Wilkinson made the following brief note on the sedimentary rocks of Parkes and Forbes, while on a short trip to the western district:—"The road then crosses the source of the Billabong Creek, about 18 miles from Parkes, where crop out purple fine-grained micaceous sandstones, dipping N.E. at 15°. In the next 2 miles a range is crossed composed of purple and white

* Ann. Rept. Dept. Mines N. S. Wales for 1885, p. 127.

false-bedded sandstones and soft grey shales, dipping easterly at 10° and ripple-marked; a thickness of about 400 feet of these rocks is seen in section in the road cuttings. From their lithological character they appear to be of Devonian age. At 8½ miles east of Parkes we leave them and come upon Silurian rocks traversed by quartz reefs; in the former quartz reefs seldom seen. The Silurian formation continues thence to Parkes, where it is intruded by the diorite dyke-mass, which extends northerly from Forbes, and in the vicinity of which the principal gold-workings occur.

"Some of the prospecting shafts on Scrubby Plains reached a depth of 161 feet, passing through yellow ferruginous and white sandy clays, pipeclay, and a little quartz-pebble drift, partly cemented with ironstone and containing colours of gold; the bed-rock is silurian slates with quartz veins."

(*a*) *Ordovician* (*?*).

The belt of sediments here provisionally classed as Ordovician has been traced northwards from the Lachlan River banks (about 2 miles south of the post office at Forbes) to the divide between the Bogan River and the Billabong Creek waters, a distance of about 32 miles. It is more than probable that the belt extends considerably farther to the north, but the present geological survey of the Forbes-Parkes gold-field has not been carried beyond this point. To the south it passes under the Lachlan River alluvium; eastwards it is bounded in great measure by the alluvium and the Devonian rocks; while quite close to the township and to the Lachlan Reefs the Silurian sediments are separated from the rocks under consideration by a narrow belt of alluvium. The strike of the sediments varies from north and south to north 15° east and south 15° west. The dip is variable, the rocks of the system having been strongly folded. The sediments themselves consist of breccias, tuffs, arenaceous clayshales, slates, carbonaceous slates and limestones, which have been highly altered. The alteration is more emphasised along certain lines than along others; nevertheless the zones of alteration always coincide with the general strike of the gold belt. The limestones, which contain encrinite stems, have been converted to marble with a development of a schistose structure in places. Shales have been converted into slates, into phyllites, and even into schists in places, as at the Aldrich Trig. Station. A strong cleavage has been induced in these rocks, the traces of the bedding planes having practically disappeared. The breccias, along certain lines, have had augen-structures developed within them, while in others the individual fragments of the breccias have been drawn out into fine films of carbonaceous material, examples of such action occurring all along the line of the Lachlan Reef workings. In other places the coarser sediments underlying or overlying finer and weaker sediments have been folded steeply, with the production later of saddle-reefs, the latter class of structure being illustrated by the Magpie and Staples Reefs, which occur about 9 miles north of Forbes. The jasperoid and cherty claystones form stronger structures; in them details of crumpling are well seen; on the other hand, however, there are minor variations only in their lines of strike, one of the belts persisting in a direction about 10 degrees east of north for a distance exceeding 20 miles. Eastwards this pre-Silurian series presents a strong unconformity with the overlaying Devonian.

These sediments, again, have been intruded by andesite dykes, and moreover they contain numerous auriferous veins, which are associated with intrusive andesites. Westward, however, of this intrusive belt, occur certain lines of internal crushing, and such are often occupied by lenticular masses of auriferous material.

Certain belts of crushed rock contain much calcareous material which appears to have been drawn in part to the surface and there deposited by evaporation to form long lines of calcareous tufa, commonly regarded as limestone beds. It appears to be a product mainly due to the action of great solar heat in drawing material in solution to the surface, and there depositing it because of semi-arid conditions.

It has been mentioned previously that no fossils have been found in this series whereby their age might be ascertained. Moreover, the rocks of definite Silurian age to the west reveal no junctions with the mass of sediments under consideration, whereby the relations between the two systems might be understood. Nevertheless the evidence available points to a pre-Silurian, probably an Ordovician age, for these sediments. For it may be mentioned that the neighbouring Silurian sediments, although possessing a similar strike, yet have not been folded sharply like those of the gold belt. Neither do they possess zones of crushing. In the second place the Silurian sediments are not cleaved, neither have their bedding planes been obliterated to any considerable extent. Furthermore the Silurian series contains no gold veins, while the other series is full of them. Furthermore, the peculiar andesite intrusions connected with the gold veins are not represented in the adjoining series. Another point of interest may here be mentioned as bearing on this question of relative ages. In Parish Currajong certain uncleaved rocks have a north and south strike. With these are associated ordinary limestones and marbles. Immediately, however, to the east occur the rocks of the gold-belt, such as altered limestones, schistose slates, having a strike of north-north-east and south-south-west.

Ordovician rocks are not absent from the district, for at Tomingley graptolites of this age have been recorded by Mr. W. S. Dun* from collections made by Messrs. Danvers Power and Card in 1898. The graptolites were first discovered by Mr. F. Danvers Power at the Myall Reefs, Tomingley, in 1897.† The specimens described are Chinacograptus and Dicellograptus.

Mr. R. H. Cambage also found graptolites in this locality during the year 1899. These graptolites were subsequently described by Dr. T. S. Hall as *Dicellograptus*, cf. *e'egans*, Carr.; *Diplograptus Carnei*, T. S. Hall; *D. foliaceus*, Murch.; *D.* cf. *Whitfieldi*, J. Hall; *Climacograptus tubuliferus*, Lapw.; *C.*, spp. ind., *Dictyonema*, *Callograptus* cf. *Salteri*, J. Hall; and *Dendrograptus*.‡

Tomingley lies about 60 miles north of Forbes, and the line of strike of the gold belt here considered, as mapped between Forbes and Alectown, would pass close to Tomingley if continued to the north. In addition to this the lithological characters appear to be somewhat similar in both districts. Thus Mr. Dun, in his description of the Tomingley graptolites, mentions their occurrence in "a bluish-gray lustrous slate." This description would answer that of many of the slates of the gold belt under consideration.

If this large area of rocks stretching from the Lachlan River south of Forbes to Tomingley be of Ordovician age, as it appears to be from the evidence here presented, then the outcrops of rocks of this age in New South Wales is not of such rare occurrence as had been believed until quite recently. Up till 1896 rocks of this age had not been recognized in New South Wales. In that year Mr. J. E. Carne, Assistant-Government Geologist, while conducting a prospecting expedition

* The Occurrence of Graptolites in the Peak Hill District. Rec. Geol. Survey N. S. Wales, 1898, V, p. 183.
† Ann. Rep. Dept. Mines N. S. Wales for 1897, p. 261.
‡ Rec. Geol. Survey N. S. Wales, 1902, vii, pp. 49-59.

along the Victorian border, from Cape Howe to the head of the Murray River, found abundant graptolites in slates, which were determined to belong to the Ordovician period by Mr. W. S. Dun.*

Other workers since that time have discovered rocks of similar age in the southern half of the State. Thus, in 1897 and 1899 came the finds already mentioned from Tomingley.

In 1899 again Mr. E. F. Pittman, the Government Geologist, found graptolites of Ordovician age at Mandurama.† These forms were described by Dr. T. S. Hall as *Climacograptus affinis*, T. S. Hall; *Diplograptus manduramæ*, T. S. Hall; and *D.* sp.‡ During the same year Mr. R. H. Cambage § collected specimens of graptolites at Orange, also of Ordovician age.

Another discovery of Upper Ordovician graptolites was made by Mr. J. E. Carne‖ on the 27th July, 1907, at Tallong, near the head of the Shoalhaven River.

The following forms were identified by Dr. T. S. Hall:— *Dicellograptus elegans*, Carr.; *D.* sp., *Dicranograptus Nicholsoni*, Hopk.; *D. hians*, var. *apertus*, T. S. Hall; *D.* cf. *cyathiformis*, Elles & Wood; *D.* sp. *Diplograptus foliaceus*, Murch.; *D. Carnei*, T. S. Hall; *Climacograptus bicornis*, Hall; *C.* sp., *Cryptograptus tricornis*, Carr.; *Glossograptus quadrimucronatus*, Hall.¶

Dr. W. G. Woolnough,** of Sydney University, also independently found graptolites in this series at a slightly later date.

Thickness of pre-Silurian Beds.

It was impossible at Forbes and Parkes to form even an approximate estimate of the thickness of the so-called Ordovician series. But that it is of great thickness cannot be doubted—probably as much as several miles. This is evident from the fact that the main rock belts composing the system do not appear to be duplicated within the boundaries of the area mapped, but extend for 10 miles to the east, with varying but high angles of dip.

The main sections at the end of the report illustrate the probable relation of Silurian and Ordovician (?) sediments. Fig. 1 illustrates a section across the pre-Silurian (?) rocks at Mumbidgle Trig. Station.

(b) Silurian.

Sediments of this age occur immediately to the west of Forbes, and consist of sandstones, quartzites, tuffs, conglomerates, limestones, claystones, and cherty claystones. They may be traced northwards along their strike from the banks of the Lachlan River for a distance of about 12 miles, whence they pass under the alluvium of the Billabong Creek. After crossing the black-soil plain, formed by the Billabong alluvium, in the direction of the strike of the Silurian rocks, one finds the typical Silurian sediments (developed south of the alluvium) to have been replaced in part by huge andesite flows, sills, by volcanic tuffs, shales, lenses of limestone, and by other rock types. Where definitely proved, the Silurian has a strike which almost parallels that of the associated but older sediments. It appears to be of the nature of a denuded anticline, the summit of which has been worn away,

* Ann. Rept. Dept. Mines N. S. Wales for 1896, p. 101; see also Dun, W. S. Records Geol. Survey N. S. Wales, 1897, V, pp. 124–127; Hall, T. S., *op. cit.*, 1902, vii, pp. 49, 59.
† Records Geol. Survey N. S. Wales, 1900, vii, p. 1.
‡ Records Geol. Survey N. S. Wales, 1900, vii, pp. 16, 17.
§ Journ. Roy. Soc. N. S. Wales, 1899, xxxiii, p. xli.
‖ Ann. Rept. Dept. Mines N. S. Wales for 1908, p. 171.
¶ Records Geol. Survey N. S. Wales, 1909, viii, pp., 339, 340.
** Proc. Linn. Soc. N. S. Wales, 1909, xxxiv, pp. 783, 784.

leaving both limbs. The central area is a mass of crumpled and indurated claystones, and represents a plunging anticline, which at first sight suggests a pre-Silurian mass. From its general lithological characters, its lack of cleavage planes, its anticlinal structure, so closely related to the associated Silurian anticline, it has, however, been referred here to the Silurian period.

A curious point concerning the junction of the Silurian and the pre-Silurian in the Forbes-Parkes District may be here mentioned. It has been already mentioned that the Silurian rocks are neither cleaved nor much crumpled, while the sediments to the immediate east have been intensely cleaved, crumpled, and intersected with numerous andesites and gold veins. Nevertheless, as the Silurian series is traversed from the core of the anticline towards the gold belt, the dip increases, but always is inclined to the older gold belt, until at a point near the contact it dips against the belt at an angle varying from 55° to 75°. Beyond this series of observed dips, the surface is cloaked with a waste sheet. It is quite possible that this dipping of a younger against an older mass has been occasioned by an overthrust fault, and this interpretation has been adopted in the appended section, illustrating the structure of the field.

Fossils.—Forms of life, of undoubted Silurian age, occur throughout the series. The determinations of these are by Mr. W. S. Dun.

Fossils from Eastern Limb of Anticline.

1. Parish Forbes, county Ashburnham, R. 38,699, near por. 335.
   Favosites, sp. nov. (small corallite type).
   Stromatoporoid, indet.

2. Parish Forbes, Quarry S. of por. 306, 3¼ miles from Forbes.
   Zaphrentoid coral, cast (*Petraia* ?)
   Tryplasma.
   Cyathophyllum, cf. *Shearsbyi*, Eth. fil.
   Favosites.
   Heliolites.
   Encrinite, stemossicles.
   Cystoid (?) (impression of plate).
   Leptæna rhomboidalis, Wilck., var.
   Orthothetes Shearsbyi, Dun.
   Pentamerus.
   Encrinurus.
   Phacops.
   Hausmannia meridianus, var. nov.

3. Parish Forbes, near Forbes, Burrawang-road, T.S.R., near W. boundary of por. 1262.
   Pterinæa, sp. nov.

4. Parish Mumbidgle, county Ashburnham, por. 77.
   Tryplasma, cf. *vermiformis*, Eth. fil.
   ,, *liliiformis*, var. nov.
   Cyathophyllum.
   Favosites.
   Pachypora
   Syringopora.
   Halysites
   Heliolites.
   Encrinite, stem ossicles.

From Centre of Anticline.

5. Parish Bocobidgle, county Ashburnham, por. 71.
   Favosites.
   Heliolites.
   Plasmopora, Sp. nov.

From Western Limb of Anticline.

6. Parish Bocobidgle, county Ashburnham, por. 119, near S. boundary,
   Halysites Australis, Eth. fil.
7. Parish Bocobidgle, county Ashburnham, por. 75, *Heliolites.*
8. Parish Bocobidgle, county Ashburnham, por. 112, *Tryplasma.*
   Heliolites.
9. For Devonian (?) fossils, see page 25.

Sandstones, Quartzites and Tuffs.—These form a long low ridge, stretching from the Lachlan River at a point about a mile and a half west of Forbes right through parishes Forbes and Mumbidgle, and in part through parish Martin. To the south the series is distinctly tuffaceous, forming hard bluish-grey layers much prized for road metal by reason of its calcareous content. Thin beds of coarse and fine-grained sandstones and quartzites are interbedded with the arenaceous tuffs, while manganese stains and secretions are common. Some of the characteristic fossils of Forbes have been obtained from this belt and its associated lenses of limestone. As one goes north along this series, the tuffaceous element is less pronounced, and the quartzitic and sandstone characters become more pronounced. At the same time the fossil contents have been reduced almost to zero, and the dip has increased in value from 55° east to about 70° east.

Limestones.—These may be divided into two classes, the fossiliferous and non-fossiliferous.

Of these, the latter consists of well-bedded masses of an impure grey calcareous type, useless for purposes of limemaking.

The fossiliferous variety is generally dark in colour, lenticular in shape, and full of fossil fragments, particularly brachiopods and corals. This limestone is much sought after by limeburners, and some of the rock lenses have been completely removed by them. One patch well-known to the burners because of its dense fossil contents has been converted altogether into lime, and the cause of palæontology has suffered somewhat in consequence.

Conglomerates.—These appear only as isolated patches at the surface in the Forbes-Parkes district, nevertheless the patches are doubtless fairly continuous below the surface. Much information is to be gained from a study of them. At times they are coarse in texture and occur as large lenses, the individual pebbles and boulders being composed of diorite, granite, porphyries, quartzites, jasperoids, and other rock types not to be found in the district to-day. Patches of old coral reefs form lenses among them, and limestone and strong coral fragments frequently form a cement in the conglomerate pebbles. *Cyathophyllum* and *Halysites* are to be found in this cementing limestone. At other times the cementing material is composed of tuffaceous material, in which are to be seen bright crystals of ferro-magnesian materials. The conglomerates on the western side of the anticline of Silurian sediments are thicker but of finer material than those to be found to

W. **Sketch section across Mumbidgle Trig. Station.** E.

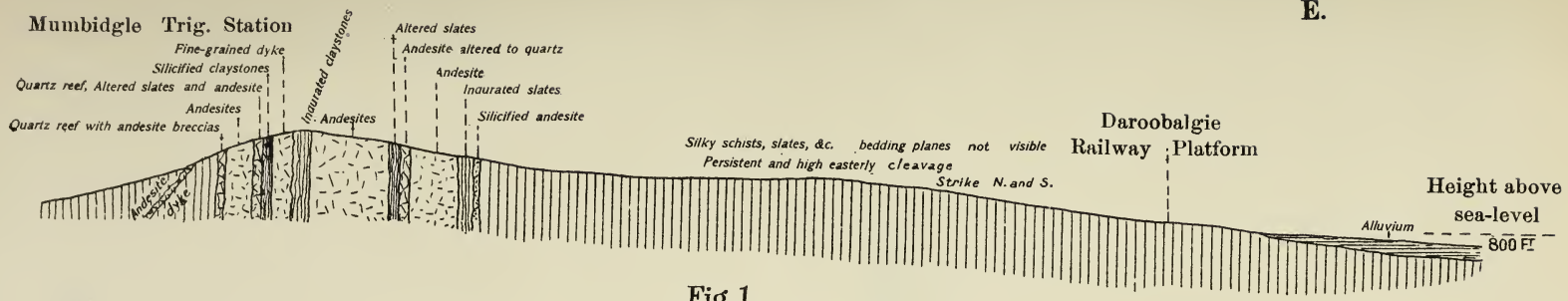

Fig. 1.

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Section across Quarry for road metal near Cemetery, at Forbes

Section normal to strike *Dip 55° E.S.E.*

Abundant Marine Silurian Fossils

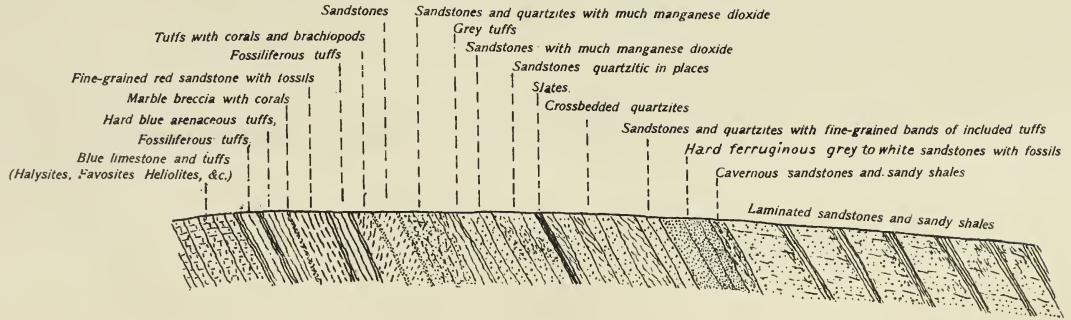
Sandstones
Sandstones and quartzites with much manganese dioxide
Grey tuffs
Tuffs with corals and brachiopods
Fossiliferous tuffs
Sandstones with much manganese dioxide
Sandstones quartzitic in places
Fine-grained red sandstone with fossils
Slates.
Marble breccia with corals
Crossbedded quartzites
Hard blue arenaceous tuffs,
Sandstones and quartzites with fine-grained bands of included tuffs
Fossiliferous tuffs
Hard ferruginous grey to white sandstones with fossils
Blue limestone and tuffs
(Halysites, Favosites Heliolites, &c.)
Cavernous sandstones and sandy shales
Laminated sandstones and sandy shales

Fig. 2.

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the east. Quartz and siliceous material predominate in the western pebble masses, and they show affinities with certain pre-Silurian sediments of the area under discussion. It may here be mentioned that there is an element of uncertainty with regard to the age of some of the conglomerate patches to the west. Some of them appear to be bedded decidedly with undoubted fossiliferous limestones and tuffs of Silurian age, while similar masses occur immediately under sandstones, possibly belonging to the marine Devonian beds. These will receive attention when discussing the Devonian rocks.

About a mile and a half north-west of Forbes a patch of river-drift occurs near the site of the old Cemetery Reserve. The pebbles in this drift do not appear to be of rocks occurring in situ in the district, and they doubtless have been derived from the Silurian conglomerates, whose line of strike is close by.

The first idea suggested by the sight of this massive conglomerate is that it is basal. The fossil evidence, however, shows that it is not so. Moreover, instances of the occurrence of heavy conglomerate series in the middle of a system are not uncommon, for example, the massive examples from the Permo-Carboniferous of New South Wales.

Claystones.—These are referred to on the map as the Cotton Series, from the fact that the Cotton Trig. Station is built on the highest point of a long ridge of these beds. They are in the form of indurated and laminated claystones, grey to yellowish-brown in colour. They are also very tough in nature, and thus form long lines of hills. Another point of difference existing between these sediments and the associated cherty claystones lies in the fact that the latter break into numerous small hard fragments of lozenge shape, which produce a crunching sound when walked upon, while the claystones split into long flat tabular pieces.

Indurated and Cherty Claystones.—In these the indurating element is mainly silica and lime, the texture is fine, and the joint systems are closely set together. The bedding planes are also not widely separated.

Fig. 2 illustrates a detail of the Silurian section. The main sections at the end of the report illustrate the supposed relation of the *Silurian* sediments and the Gold Belt.

Devonian.

Immediately above the limestones of the western limb of the Silurian sediments, a doubtful junction of the Silurian and Devonian systems may be seen. This junction is represented by a dotted line in the accompanying map, passing through parishes Bocobidgle and Mumbidgle. In the limestones characteristic fossils of the Silurian occur, namely, *Halysites*, *Heliolites*, *Tryplasma*, *Favosites*, and others, while in the massive sandstones immediately overlying them, the fragmentary and unsatisfactory fossil evidence rather favours a Devonian than a Silurian age for the younger beds. It must be remembered, however, as Mr. Dun, the Government Palæontologist, points out, that the fossils on which this tentative classification is based in no single case are either perfect or of really distinctive types. They consist of poorly preserved specimens of :—

(*a*) *Rhynchonella*, *Pterinæa*, *Pleurotomariod*, parish Bocobidgle, por. 112,

(*b*) *Pterinæa*, sp. nov., parish Bocobidgle, por. 145.

(*c*) *Orthis*, parish Bocobidgle, por. 158.

The matrix consists of massive and coarse siliceous marine sandstone and arenaceous or tuffaceous shales. The strike is generally parallel to that of the underlying Silurian, nevertheless bending slightly towards the west when traced northwards. These sandstones, moreover, appear to be comformably bedded with the associated Silurian, each being inclined at a low angle to the west.

West of this strong sandstone ridge a broad plain of alluvium is entered upon, which ends abruptly against a long high ridge of quartzites and sandstones, possessing a dip to the west, and which varies in amount from 10° to 15°. The ridge attains a general height of 500 feet above the plain, it is rarely half a-mile in width, and it is notched with deep gaps whose bases are occupied by alluvium and through which the larger watercourses of the district flow in their passage west to the "Black-soil" plain which spreads out immediately after passing through the small gaps in the narrow quartzite range. The quartzite ridge simply represents the survival of a hard and gently-dipping belt of rocks, the weaker associated members of which have been denuded and buried under recent alluvium. Plant remains have also been found in these beds, the following determinations of them having been made by Mr. W. S. Dun:—

(*a*) Parish Jemalong, county Forbes, Jemalong Range, "Jemalong Gap."
Archæocalamites (?)
Lepidodendron australe, McCoy.

(*b*) Parish Carrawabbity, county Ashburnham, Carradgery Range, near Jemalong Gap.
Calamitoid remains.

From the Jemalong Gap also, in this belt of rocks, a dermal plate of an Asterolepid fish, apparently a new species, and preserved as an impression in a coarse-grained Devonian sandstone was collected by Mr. R. H. Cambage,* the Chief Mining Surveyor.

On account both of these fossil remains and the lithological characters of the sediments themselves the series has been referred to the Upper Devonian.

If attention is directed to the high ranges east of Parkes which are composed partly of granite and partly of quartzites, sandstones, and shales, overlying flinty and cherty claystones it will be seen that the overlying quartzites dip easterly at an angle not exceeding 10° while the underlying rocks dip westerly at angles varying from 45° to 80°. Two sketch sections taken among the foothills alongside the Parkes Waterworks are here reproduced so as to show the general relations existing between the granite, the claystones, and the quartzites. Associated with the younger rocks, but lying still farther east, are bands of brown, greenish, and grey shales. Associated with this basal layer of coarse and gritty sandstones are great masses of alternating sandstones, quartzites, and chocolate shales, totalling more than 5,000 feet in places.

The basal beds of the sandstones are coarse and gritty, while the overlying quartzites are finer in texture. No fossils, with the exception of Lepidodendron remains, have been found in this locality, but the series is here referred provisionally to the Upper Devonian for the following reasons:—

(1.) The lithological characters of the rocks are similar to those described by Mr. C. A. Süssmilch† for a group of sediments west of the Canobolas Mountains at Orange, and from which fossils of definite Devonian age have been obtained by the same observer.

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*Ann. Rept. Dept. Mines N. S. Wales for 1899, p. 207.
†Journ. R. Soc. N. S. Wales, 1906, XL, pp. 130-141.

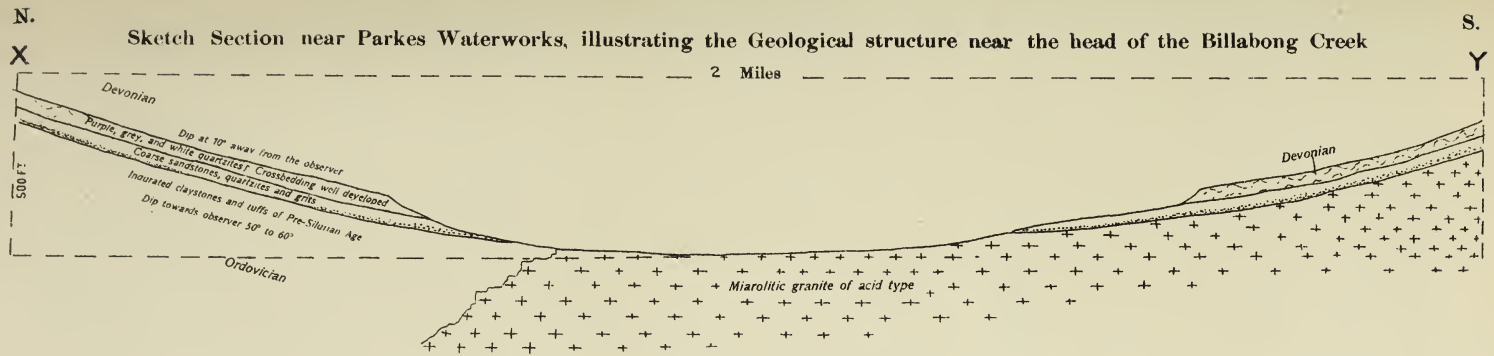
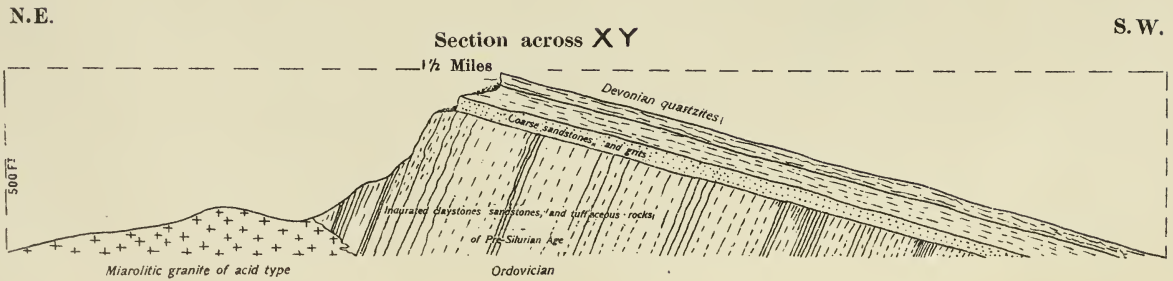

N.
S.
X
Y
Sketch Section near Parkes Waterworks, illustrating the Geological structure near the head of the Billabong Creek
2 Miles
Devonian
Purple, grey, and white quartzites. Crossbedding well developed
Dip at 10° away from the observer
Coarse sandstones, quartzites and grits
Indurated claystones and tuffs of Pre-Silurian Age
Dip towards observer 50° to 60°
1,500 Ft.
Ordovician
Miarolitic granite of acid type
Devonian

Fig. 3.


N.E.
Section across XY
S.W.
1½ Miles
Devonian quartzites
Coarse sandstones, and grits
Indurated claystones, sandstones, and tuffaceous rocks
of Pre-Silurian Age
500 Ft.
Miarolitic granite of acid type
Ordovician

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(2.) A set of fish scales, apparently of Devonian age, has been found by Mr. J. E. Carne, Assistant Government Geologist, from the Harvey Range a little north of the area under consideration, and in rocks which appear to be continuous with those surrounding the Parkes water supply area.

Viewed thus the Devonian appears to have formed a gently-arched dome over the Forbes-Parkes district, the dome from Jemalong Gap to the Parkes waterworks being about 30 miles across. The upper portion of the mass has been greatly denuded, and survives now only in several ridges possessing gentle dips.

Tertiary.—No sediments of Tertiary age occur in the district under consideration, but the broad valley of the Lachlan River has evidently been excavated in Pliocene time. This idea is based on the analogy of work known to have been accomplished both in Australia and in foreign countries by rivers in Pliocene time The sediments of Pliocene age evidently lie still farther to the west under the "Black-soil" plains.

Pleistocene.—To this period may be assigned the leads and the alluvial plains of the district. No fossils have as yet been named from the leads, and the evidence for this assigned age is physiographic. The former greater extension of the alluvial plains is shown by the denuded terraces and islands of black soil and sand which occur at heights of from 20 to 30 feet above the present level of the plains. The Harvey and Bumberry Ranges, which form the great eastern wall to the Coobang and Bogan Rivers, appear to be an upfaulted block of Pleistocene age.

Under the alluvium in Mr. Hasemer's brickpit at Forbes, and at a depth of 18 feet below the surface, Diprotodon bones have been found in association with aboriginal ovens. Mr. Warden Sharpe also forwarded Diprotodon bones from the Parkes alluvium.

B. Igneous Rocks.

These may be grouped as follows:—

(*a*) *Granites* of Middle Palæozoic age.

(*b*) *Contemporaneous lava flows.*

i. Andesites with cryptocrystalline bases, and amygdaloidal in places.
ii. Banded andesites of Parkes.

(*c*) *Intrusive andesites.*

i. Andesites of the gold belt.
ii. Compact andesites east of the Gold Belt.
iii. Massive andesites west of the Gold Belt.

(*a*) *Granites.*

Rocks of this type are not indicated on the map. Eastwards of Forbes, however, they have a great development, extending at least from Eugowra to the site of the Parkes waterworks. Doubtless they extend also still farther to the north. The general relations of these plutonics and the associated sediments are shown in the sections taken across the country (Fig. 3). As shown by such sections, the granite is overlain by rocks whose age is Devonian, while the igneous rock in turn apparently intrudes the pre-Silurian sediments.

The rock is of acid type, and in texture it varies from coarsely-granular to micrographic, miarolitic, and finely-grained mixtures of quartz and felspar, in which are present thin flakes of a variety of dark mica. Frequently the rock possesses a reddish colour, and weathers out as large ellipsoidal blocks and tors, while at other times it breaks down into cavernous and friable masses.

If the old series of rocks associated with it are indeed Ordovician, then it is very probable that the granites briefly described here were injected into the earth's crust during the period of decided mountain-making which closed the Ordovician in this region.

(*b*) *Lava flows.*

i. Andesites with stony bases.

The Andesites with glassy bases, of parishes Parkes, Currajong, and Goobang, form a peculiar group. If one follows the line of intrusive andesites with which the Nibbler's, Koh-i-noor, Buchanan, Bonnie Dundee, Bushman, and Dayspring mines are associated, one comes to a vesicular basalt near the Currajong Public School, which passes immediately to the north into andesites with fine-grained bases.

In parish Goobang, the mass formed by them is about 5 or 6 miles in length, and from 2 to 3 miles in width. (See general map.) Gold is reported therefrom in small quantities, as, for example, at the back of the Parkes Trigonometrical Station on Nash's Hill; but it is doubtful whether gold in payable quantities is associated with the rock, unless, perchance, at spots where it may have been intruded by later andesites in turn, or at spots where zones of crushing have been developed. Associated with the mass under consideration are coarse breccias, or inclusions of basic augitic andesites.

In these pages the rock has been classed as a lava flow contemporaneous with the associated sediments. On the other hand, in the vicinity of the rifle butts at Parkes, it appears locally to have an intrusive origin. The glassy appearance of the base is not a sure proof of its extrusive nature even when occurring in such great masses as that just described, but coupled with the vesicular nature of the rock in places, it is a legitimate conclusion that the rock is of eruptive nature.

The following petrological notes on this rock have been supplied by Mr. G. W. Card, Curator of the Mining Museum. The numbers supplied in these petrological descriptions are those in the Catalogue of Rocks in the Mining Museum:—

No. 7641. portion 15, parish Goobang, county Ashburnham.—Hand specimens of this rock are jointed and possess a horny texture and a sub-even fracture; greenish-blue weathering, also red and brown, with pitted surface.

Under the Microscope.—Comparatively fresh augite is revealed in an isotropic yellowish base. Much secondary silica is present; felspar is barely recognisable as such, as its traces are almost obliterated.

In other specimens an amygdaloidal or vesicular structure is present. Traces of epidote also occur.

ii. Banded Andesites of Parkes.

These are of dull-green to grey colours and occupy a long north and south belt extending from the Billabong Creek, near Tichborne, to a point several miles north of Parkes. The extent of the occurrence may be seen by a

reference to the general map in parishes Parkes and Currajong, and the boundaries are shown by dotted lines because of the impossibility of mapping them accurately. No two independent observers would decide upon the same boundaries. One reason for this is the fact that with this series of andesites are associated thin lines of slates, chloritic schists, tuffs and cherty claystones; these bands being very narrow and their outcrops being almost negligible in area they have been included with the associated andesites. Furthermore, owing to the lack of rock outcrops the eastern and western boundaries of the andesitic belt could not be determined with any amount of precision. Such outcrops as were seen form low hills whose longer axes lie in a north and south direction and give rise to the impression that one is looking at rows of slates standing on edge. This suggestion of steeply-dipping or cleaved sediments is strikingly apparent. Only upon closer examination are the rocks seen to be porphyritic lavas with a well developed flow structure. The surfaces due to parting along lines of flow are rough and platy, and the fracture across these planes is very uneven and hackly. Zones of strong crushing are arranged parallel to the strike of the lavas, and gold deposits have been developed in such zones of stress. Several leads also head in this andesite belt. The auriferous quartz veins of this belt are at times lenticular in shape, and frequently the external surfaces of the quartz lenses curve sympathically with the associated flow surfaces of the andesite. At other places in this andesite mass the quartz veins are more of the nature of a stock-work.

The soil derived from the weathering of these rocks is reddish to brownish-red in colour. Mr. Card's description of a rock from this belt is as follows :—

No. 7647. Locality T.S.R. 16,016, parish Currajong.—Colour dull-green, platy. Hackly fracture across fissility. Small felspar phenocrysts weathering out in relief.

Under Microscope.—Platy structure due to parting along lines of flow indicated by felspar microlites. Plagioclase phenocrysts calcified in part. These lie to some extent across the lines of flow; twinning not obliterated but rather obscure. Magnetite plentiful.

(*c*) *Intrusive Andesites.*

With the belt of sediments provisionally assigned in these pages to the Ordovician, a great number of lines and lenses of andesite are associated. These are shown on the map in the parishes of Parkes, Currajong, Goobang, Goonumbla and Dowling.

In the field they appear as long rib-like or lenticular masses rising out of the plain of alluvium or waste, inasmuch as they represent the survivals of the more durable rocks of the district, the associated sedimentary rocks having been removed or buried beneath the cloak of waste which forms the greater portion of the superficial geology. Thus the relations of the sedimentary beds and these igneous masses are obscured. For this reason also the following description of the andesites is not at all complete :—

i. Andesites of the Gold Belt.

Under this title are included an interesting group of rocks which occur as dykes and sills throughout the greater part of the distance extending from the Britannia Mine, south of Forbes, to the Dayspring Mine, situated about two miles north of Parkes. Northward of the latter

mine the andesites under consideration appear to give place to an andesite which on first appearance appears to contain a glassy base. The belt is exceedingly narrow, as may be seen by a reference to the map. The bulk of the important gold reefs, such, for example, as the Britannia, the Lachlan, the Koh-i-noor, the Buchanan, the Bushman, and the Dayspring, are intimately related to this intrusive line, and appear in some way to depend not only on the dykes and sills under consideration for their gold values, but on them also for their very existence. Nevertheless, in the vicinity of many of the reefs the andesite itself may be seen to have been intensely altered by the auriferous solutions themselves, thus showing that the andesites must have consolidated before the ore entries had been effected, and that the fissures developed both alongside of, and across, the igneous rocks had formed guiding lines for the hot wandering solutions. In many cases the andesite has been almost completely altered to impure quartz in this process. At its junctions with the associated sediments large impure quartz veins and breccias frequently occur. Such breccias have arisen generally in the first place by a fine shattering action among the country rocks, and in the second place to a subsequent percolation of them by siliceous solutions. By this means the quartz gradually ate away the walls of the tiny cracks and replaced the country, whether of sedimentary or igneous origin, by impure quartz. Frequently this replacement action was not complete. Brecciated appearances have thus originated. In texture the rock varies remarkably. Thus, in some mines, the same rock has been described as belonging to two distinct types—namely, diorite and felsite.

The age of this rock type is unknown, but it is absent from the neighbouring Silurian. The gold veins also are absent from the latter formation. The intrusive andesites thus may be pre-Silurian in age.

The following petrological notes are based upon the examinations by Mr. Card of rocks, whose catalogued numbers are:—7598, 7601, 7602, 7603, 7604, 7607, 7608, 7654, 7655 and 7664.

Macroscopic. — Rocks commonly compact, pale green, greenish grey, uneven to sub-even fracture, frequently jointed, possessing abundant felspar phenocrysts, sometimes exceeding one quarter of an inch in length, with hornblende and augite phenocrysts also. The felspars are frequently clouded and twinning is obscured. Chlorite and calcite are commonly seen in the ground mass.

Microscopic.—The felspars at times are comparatively fresh, the ferro-magnesian minerals are often highly altered. Secondary minerals are frequently developed, such as chlorite and magnetite. Apatite is present as conspicuous crystals in the ground mass. The ground mass itself is frequently massive, granular, or microcrystaline. The types are rarely dioritic, and almost in every case andesitic.

ii. Compact andesities east of the gold belt.

The occurences are lenticular patches and long lines of low hills in parish Dowling. Mapping of these andesite masses was difficult, owing to the great amount of alluvium present. At times they have the appearance of light coloured basalts, at others of indurated and flinty sediments. Their relations to the associated sedimentary formations are not known. They are here classed as intrusives.

iii. Massive andesites west of the gold belt.

Rocks answering to this description occur as very long lines, sometimes attaining a width of a mile. The associated rocks are limestones and indurated shales. Of these associates the former are rarely visible, being covered by a cloak of waste and alluvium. Although altered at times to an impure marble, they do not appear to have any developments of idocrase, garnets, or similar minerals within them, such as one might expect from their proximity to masses of basic andesite a mile in width, provided that the latter be of intrusive nature. Near the junctions of the igneous masses with the associated sediments, however, one finds at times large masses of siliceous and ferruginous material suggestive of the action of hot water on sediments, and this would favour the assumption of an intrusive origin for these rocks. Included masses of angular, rounded, and ellipsoidal fragments of more acid and more basic igneous rocks are of common occurrence.

Possessing only this scanty information concerning the north and south lines of andesites under discussion, it is, perhaps, advisable to assign to them an intrusive origin, the intrusions being of the nature of sills.

The following petrological notes on this group have been supplied by Mr. G. W. Card :—

Rock specimen 7637. From portion 73, parish Goonumbla. Porphyritic andesite with augite. Creamy plagioclase phenocrysts, up to half-an-inch in length, tabular in habit. The weathered surface shows an abundance of these phenocrysts standing out in relief. Lamellar structure in places is well brought out by this weathering ; the fracture is even.

Under Microscope.—Much opacity is evidenced throughout by reason of alteration, but the twinning of the felspar is still distinct. Augite is occasionally present more or less altered, and shows the development of a small amount of epidote and magnetite. Slight epidotisation has also been set up among the felspars.

7646.—Augite andesite from Miller's Look Out, near north-east corner of portion 791, in parish Currajong.

Macroscopic Characters.—The rock is grey in colour, and contains much plagioclase, and some augite as phenocrysts. The average size of the largest of the phenocrysts is about a quarter of an inch in length. The fracture is sub-even. Weathers to a buff colour. The surface of the rock is pitted.

Microscopic Characters.—The ground mass is dense, with abundant black pigment spots. The felspars are completely clouded, and are recognisable by their outlines only. The augite is fresh, and occurs as small automorphs. Magnetite is plentiful, both in the augite and in the ground mass. Apatite is conspicuous, both in the ground mass and in the augite.

VIII.—ECONOMIC GEOLOGY.

The minerals worked in the Forbes-Parkes district are gold and copper, but the copper deposits are so relatively unimportant that they may be neglected in this discussion.

The auriferous deposits fall naturally into three groups, namely :—

A. The "Leads."

B. The quartz veins associated with the intrusive andesites.

C. The auriferous quartz masses in "zones of crushing."

A. The Leads.

General Description of the Leads of Parkes and Forbes.

The gold deposits contained in these superficial and buried deposits of river drift represent concentrations, more or less payable, of gold which has been derived from the quartz reefs in the locality.

In the description of the leads, it will be advisable to deal firstly with their origin ; and secondly, both with the manner of leasing the ground and with the methods employed in working the alluvial claims.

(1) *Origin of the Forbes-Parkes Leads.*

A shallow lead may be defined as a watercourse containing alluvial deposits which are open to the sky.

A deep lead may be considered as a watercourse, whose alluvial contents are buried beneath either a capping of alluvium or lava (or both).

The leads of the Forbes-Parkes District belong to both these types ; in fact, the shallow leads frequently pass down stream into deep leads. They contain gold values, and such are frequently found :—

(*a*) Along the gutters of the main channels and associated with the coarser stream deposits.

(*b*) Along the rim-rock or the sides of the buried stream channels.

(*c*) Among various and irregularly arranged patches of coarse stream material situated above the older and deeper buried stream channels.

In order to understand the origin of "leads" such as those of Parkes and Forbes it is necessary to have a distinct insight into the methods of stream action. In the chapter on Physical Geography it has been shown that under certain conditions which favour increased stream velocity rocks are worn away and stream channels are deepened ; that under other conditions which favour decreased velocity stream channels are filled with *debris*, because under the latter conditions the stream is unable to transport its load as a whole vertically above the same given point as before. Nevertheless the very existence of an alluviated valley implies the wearing down or transporting action of streams (or other agencies) in the neighbourhood, whereby the material now filling the down-stream channel has been obtained. The existence of coarse drift implies relatively rapid—while that of fine silt implies relatively sluggish—stream action.

Since rocks may be worn down by atmospheric and stream action it follows that the quartz veins associated with them may be broken down also and carried away to the neighbouring watercourses, although it is evident that

hard and insoluble rocks, such as quartz, may be worn down at a less rapid rate than the associated more soluble ones, and that they may therefore stand up more or less as walls or "blows" in the hilly country. This statement, however, needs qualification. Barren or "buck" quartz veins have very little mineral contents and they usually outcrop strongly because of their insolubility, while rich gold lodes often outcrop but slightly owing to their soluble mineral contents which by decomposition cause the lode material to be easily disintegrated.* But with the destruction of the vein material there will ensue the partial removal of the gold contents and the transportation of the same to the neighbouring watercourses. We say the partial removal of the gold advisedly because it is evident that various acids exist at and near the surface of the earth and these powerful agents must dissolve a percentage of the gold contents and such dissolved gold will tend to sink to lower levels in the vein provided suitable joints occur in the latter which allow of the ready seepage of waters. This subject, however, will receive more attention when the gold veins themselves are being discussed.

We are now in a position to understand the formation of the Forbes-Parkes leads. It has been ascertained by alluvial mining operations and by an examination of the surface of the district that at one period the Lachlan and Goobang Valleys were composed of a series of denuded valley floors rising one above the other the lowest one even possessing a distinct rock-bound channel practically free from alluvium. Now because the lower channels possessed steep sides and because their bases were also narrow and possessed steep slopes the steamers flowed fairly rapidly along them, and were therefore enabled to transport large pebbles along the gutters. A fairly coarse stream wash or drift would thus be expected along these gutters. Inasmuch, also, as the stones and pebbles of this wash would be those of the country associated with the veins, one would expect to find some of the gold contents of the veins present with the heavier drift along the gutter. Moreover, at this stage there would be abundant opportunities for the gold to travel along the channels for considerable distances, owing to the steep slopes possessed by these earlier channel bottoms

Let us now suppose that the land at this stage commences to sink gradually. In this case the velocity of the stream will gradually decrease, its transporting power will be considerably lessened, and the stream channels will be gradually filled with the *debris* derived from the hills in the vicinity. If this movement of sinking be slow and continuous the whole stream channel may be gradually filled with *débris*. But since the stream power at this stage has diminished so much, the beds of material filling the channel will not now be so coarse as the material near the base. Coarse *debris* may still be found in the channel nearer to its head, but it cannot at this stage be carried as far down the channel as formerly; so that above the coarse bottom beds one will expect to find beds less coarsely textured, such as grits, sands and shales. Similarly the gold contents cannot now be carried so far down-stream as heretofore, and thus in general one will not expect to find rich gold values in the sands and silts overlying the coarse gold drifts of the gutter. Another important point may here be noted. Gold is of high specific gravity and soon falls out of the current. In general when the stream is small and its channel is of gentle slope the gold does not appear to be carried far below the vein or lode from which it has been derived. Thus if channels of this description cut across gold reefs they will be continually enriched, but the influence of such enrichment will die away rapidly with progress downstream.

* See also Stanley Hunter. Deep Leads of Victoria. Memoirs Geol. Survey Victoria, No. 7, 1909, p. 4.

As the channel becomes filled with alluvium, any reefs which may have outcropped along the channel sides and base are slowly buried, and thus it is evident that the more an auriferous tract of country is alluviated and the more rapidly it sinks so much less is the probability of obtaining gold in the drift above the channel base, because with this rapid sinking action there is associated a corresponding sluggishness of stream action and a decided burial of the outcrops of many of the gold-bearing rocks. But there may not be continuous or rapid subsidence; on the contrary, there may be a general movement of subsidence which is accompanied by intermittent elevation at the head waters of the stream. In a case such as this the channels will become filled, but during the elevations of the associated land areas masses of coarse drift will be carried down over the sand and clay layers. It may be asked what opportunities exist for finding gold in these upper channel drifts. All things being equal they will contain gold values as well as the lower drift, but usually they will not be of so payable a nature, because, in the first place, they have not the same area of auriferous rocks over which to work, and, in the second place, their channel bases are not so steep as were those on the solid rock at the bottom, and the gold in that case cannot be carried so far downstream.

There are still other points to be considered in connection with the action of streams and the distribution of gold in alluvial deposits. Thus gold values may occur not only in the gutter, but also on the rocky sides of the channel. The reason for such uneven distribution of gold is obvious. For simplicity, let us first consider the action in the gutter, or at the base of the channel. It is a fact, long since ascertained, that ordinary stream channels have been formed by streams themselves—in other words, that streams in such cases are older than their valleys, or channels. It is a fact of observation also that the stream does very little work during periods of low or ordinary water, but depends on the period of flood to do the main work of carving its channel. This is evident also from a consideration of the elements of mechanics, for the energy of a stream appears to grow as the product of the increase of its cross-section and the cube of the increase of its velocity. In flood time the cross-section of a stream frequently exceeds 100 or even 1,000 times its cross-section when in the normal or drought stage. The velocity of the stream is frequently increased six-fold, or even more, during periods of flood. On the other hand, it is evident that so soon as the flood waters subside, the heavier material will fall out of the current, and the greatest amount of such falling out of debris will be in sheltered spots opposite cutting curves in the channel, or behind projections. Thus a strong current may be cutting into a spur. This lateral action of the stream will be accompanied by a powerful eddying motion, and such action will die away in great part on the opposite and sheltered side of the stream. The strong central current sweeps the heavier gold contents past the cutting curve along with the heavier stream material, and the eddying motion tends to carry the deposits toward the opposite and downstream side of the cutting curve, where some of the material drops out of the current. The greater the flood

the greater the agitation in the vicinity of the cutting curve, and the farther from this curve and the higher above the base are the gold and alluvial deposits then carried. Rich patches of alluvial gold are thus formed The following sketch illustrates this point. The rich auriferous flats are opposite

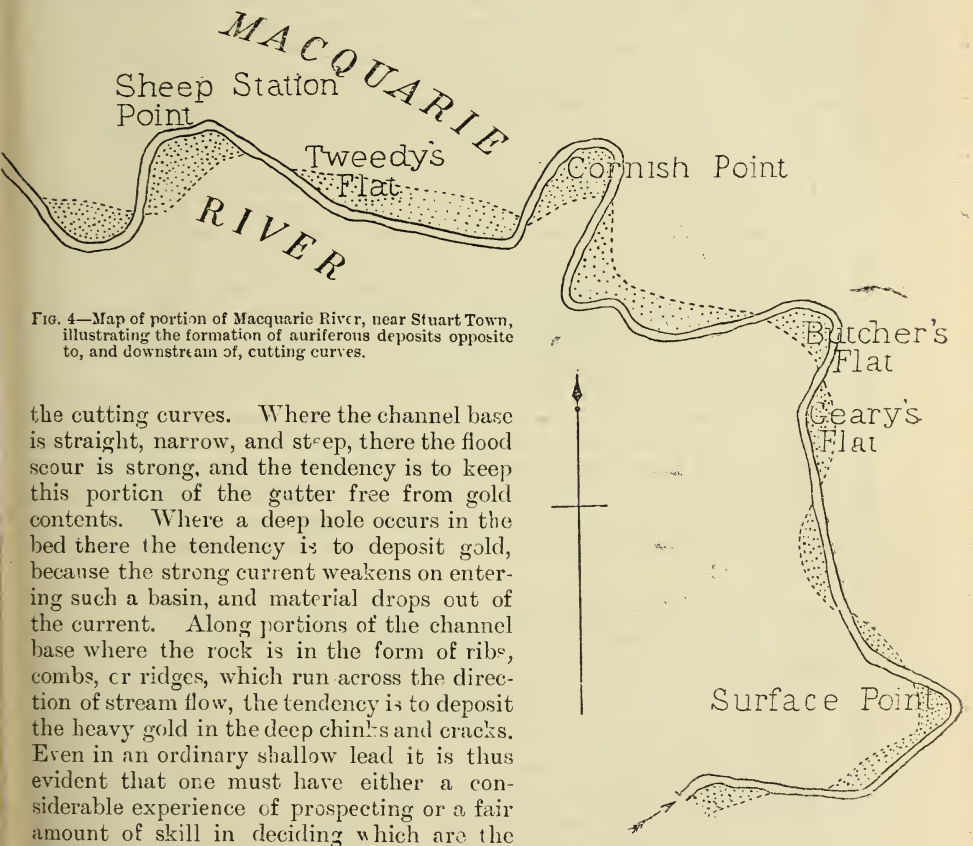

FIG. 4—Map of portion of Macquarie River, near Stuart Town, illustrating the formation of auriferous deposits opposite to, and downstream of, cutting curves.

the cutting curves. Where the channel base is straight, narrow, and steep, there the flood scour is strong, and the tendency is to keep this portion of the gutter free from gold contents. Where a deep hole occurs in the bed there the tendency is to deposit gold, because the strong current weakens on entering such a basin, and material drops out of the current. Along portions of the channel base where the rock is in the form of ribs, combs, or ridges, which run across the direction of stream flow, the tendency is to deposit the heavy gold in the deep chinks and cracks. Even in an ordinary shallow lead it is thus evident that one must have either a considerable experience of prospecting or a fair amount of skill in deciding which are the spots likely to be the most profitable. One should know the character of the rocky surroundings so as to examine that portion of the channel base and sides which is formed of natural riffles, and one should examine all the sheltered points downstream into which floodwaters might cause the gold to be lodged. Moreover, one must ascertain whether the stream flowed formerly in a slightly different course. In such a case the form and size of the channel will help him here. For instance, in a broad shallow channel a stream may have formed a series of rich pockets of gold. Subsequently a flood may have diverted the stream to the right or to the left of its old course. The observant prospector, however, will suspect the existence of such an "older" run of gold, merely by the general appearance of the channel debris.

One is now in a position, also, to understand how gold is lodged on the "rim rock," the "high reef," or channel sides, while the channel itself is being filled with stream debris. The methods of gold deposition adopted at this stage are much the same as at the time when the gutter only was occupied by the stream. For the stream can only work in the one simple way. Its carrying power is wonderfully increased when its velocity increases,

either as the result of the steepening of its basal channel slope or by increasing its volume. On the other hand, its carrying power is wonderfully decreased as the flood-waters recede. The significance of the last statement is, that at this stage the stream can move neither its heavier debris nor its coarser gold. For example, suppose that the channel has become half-filled with debris, as a result of streams dropping their loads on a sinking area. The bottom of the channel at this stage is composed of uncompacted sands, clays, or pebbles. In the case where sand and clay only are carried down there will be few or no payable gold deposits formed, because the stream strength is insufficient for the task of carrying any but the finest gold. If the stream be strong and carry coarse material during flood-time, then the gold will be deposited on the "rim rock," behind rock projections, or in spots which are relative "slacks" even during flood periods. The intervening space between the rock channel sides is so broad frequently that large amounts of wash occur, nevertheless, the stream channel is at this stage not stationary, and the gold values are so distributed throughout the drift that they are rarely valuable enough to pay the cost of mining. In this case, also there are no auriferous outcrops in the channel bottom by the disintegration of which the gutter may become replenished Nevertheless, the side streams dump some of their gold contents near the "rim rock," or else they disseminate them throughout the wash. A very interesting point may be noted in this connection. We have seen that on such a sinking area as we have been describing the streams cannot denude their bases, but can only aggrade them. In this process the gold which once settles into the pebbles and sand at the base of the channel cannot be swept further along, but will tend to settle gradually into and along the "rim rock" and false bottoms, and there collect in pockets.

From the foregoing brief account of the formation of leads it is evident that if decided difficulties are experienced by trained prospectors in the working of shallow leads, where the workings are all more or less open to the sky, then the problem becomes much more complex when one considers the exploitation of deep leads, which consist of alluvial deposits capped by broad expanses of alluvium or lava. For in such a case not only is the area to be prospected greatly increased as compared with that of the shallow lead, but the depth also is greatly increased, and all the work of exploitation has to be done by the laborious processes of mining underground in country which is generally both wet and heavy. Another circumstance which complicates the exploitation of deep leads is that which arises when the old defined channels have been filled with debris, and the whole countryside is gradually buried under alluvium.

It may be interesting to note the methods adopted by the streams in covering such an area with alluvial deposits. The alluvium will overflow the stream channels or valleys first at points downstream; then the alluvial plain will continually grow in depth and width by the progressive burial of the channels and interchannel areas upstream, much as flood-waters first occupy low-lying lands, and gradually creep higher up the surrounding slopes. As the alluvial mass overtops the old channel rims, so the streams will form fresh watercourses, and they will discharge their contents over the whole of the area of subsidence. Their channels will be ever shifting, because they possess no rock walls which can limit the movements of the streams. Where the streams leave the solid rock and pass on to the alluvium wedge-shaped masses of pebbles and drift coarser than sand in texture may be expected, while farther out and also away from the stream channels clay will be

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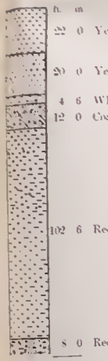
GOLD-PROSPECTING BORES, FORBES.

Bore No. 1.



ft.	in.	
22	0	Yellow clay
20	0	Yellow sand and white drift sand.
4	6	White clay, mud, and sand.
12	0	Coarse drift.
102	6	Red, yellow, blue, and white clay.
8	0	Red clay and gravel.
169	0	

Fresh water tapped at from 34 feet to 52 feet from surface.

Bore No. 2.

ft.	in.	
36	6	Red and yellow clay, with sand
23	6	Fine and coarse drift, with stones.
41	0	Red and blue clay, upper portion with stones.
3	0	Rotten or decomposed slate.
104	0	

Fresh water soakage at 31 ft. 9 in., rising 30 ft. at 60 ft. from surface. Brackish water tapped at 99 ft.

Bore No. 3.

ft.	in.	
24	0	Yellow, red, and chocolate clay.
6	6	Yellow sand.
8	0	White sand, with clay.
10	0	Fine drift sand, with stones.
1	6	White clay,
7	6	Coarse drift.
14	0	Red and white clay, with rotten slate at base.
3	0	Rotten or decomposed slate.
74	6	

Fresh water at 43 ft. from surface, rising 16 ft.

Bore No. 4.

ft.	in.	
22	3	Yellow clay.
1	3	Conglomerate.
18	0	Yellow sand and clay
7	0	Coarse drift.
1	6	White clay.
6	0	Coarse drift.
1	6	Rotten or decomposed slate
57	6	

Fresh water at 41 feet, rising 18 feet.

Bore No. 5.

ft.	in.	
21	6	Yellow, blue, and red clay.
7	0	Red and white sand.
5	6	Yellow clay.
3	0	Red and white sand
3	0	Red and white clay
12	0	Coarse drift.
1	0	Blue clay.
3	6	Coarse drift.
45	6	Red, white, and yellow clay, and red clay with stones
3	0	Rotten or decomposed slate.
105	0	

Fresh water at 44 feet, rising 18 feet.

Bore No. 6.

ft.	in.	
16	0	Yellow clay.
16	0	Clay and sand.
23	0	Fine and coarse drift.
20	6	Red and blue clay, with stones in places.
3	0	Rotten or decomposed slate.
89	6	

Fresh water at 60 feet, rose 18 feet. Brackish water at 80 feet, rose 30 feet.

Bore No. 7.

ft.	in.	
32	6	Blue and yellow clay and a little yellow clay and sand.
1	6	Hard conglomerate.
10	0	Clay with sand and fine drift.
3	0	White clay.
12	0	Coarse drift.
12	0	Yellow clay with stones, passing downward into red clay and gravel.
39	0	Red, blue, and white clay.
21	6	Clay with stones.
14	6	White and red clay.
2	6	White clay and rotten slate.
1	0	Slate.
151	6	

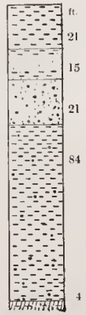
Fresh water at 49 feet, rose 18 feet. Brackish water at 116 feet, rose at 105 feet.

Bore No. 8.

ft.	in.	
16	0	Yellow clay.
2	6	Yellow clay with sand and stones.
9	6	Blue clay.
7	0	Yellow clay with sand.
6	6	Coarse drift.
1	6	Yellow clay with sand
16	0	Coarse drift.
39	0	Red clay with stones.
11	6	Red clay with stones and slate.
31	6	Red and white clay with stones.
3	0	White clay and rotten or decomposed slate.
144	0	

Fresh water at 31 ft. 6 in., rose 20 feet.

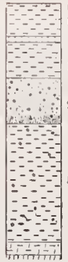
Bore No. 9.



ft.	in.	
21	0	Yellow clay.
15	0	Yellow sand and yellow clay with sand.
21	6	Fine and coarse drift.
84	6	Red and white clay with stones.
4	0	Rotten or decomposed slate and a little white clay.
146	0	

Fresh water at 31 feet, rose 18 feet.

Bore No. 10.



ft.	in.	
16	0	Red and yellow clay.
3	0	Yellow sand.
17	0	Yellow clay with sand
22	0	Fine and coarse drift.
57	0	Red clay with stones.
6	0	Red clay with rotten slate.
2	0	Rotten or decomposed slate.
123	0	

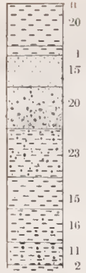
Fresh water at 42 feet, rose 18 feet.

Bore No. 11.

ft.	in.	
22	0	Yellow clay.
20	6	Yellow sand with clay.
16	6	Coarse drift.
47	0	Red and yellow clay with stones and blue clay.
11	0	Red clay with pieces of slate.
47	0	Red and yellow clay with stones and rotten slate.
164	0	

Fresh water at 49 feet, rose 6 feet.

Bore No. 12.



ft.	in.	
20	6	Yellow clay.
1	6	Yellow clay with sand.
15	0	Yellow sand.
20	0	Coarse drift.
23	0	Yellow clay with gravel.
15	6	Yellow clay.
16	0	Yellow clay with stones and blue clay
11	0	Red clay with gravel.
2	0	Yellow clay.
127	6	

Fresh water at 48 feet, rose 8 feet

Bore No. 13.

ft.	in.	
19	0	Yellow clay.
10	0	Yellow clay with sand.
5	0	Yellow sand.
15	3	Coarse drift.
97	6	Red and yellow clay with stones.
13	6	Red clay with stones and slate.
20	0	Red and white clay.
4	6	Pipeclay and rotten slate.
184	6	

Brackish water at 46 feet, rose 12 feet.

Bore A 14

ft.	in.	
13	0	Yellow clay.
10	6	Yellow clay with sand.
9	0	Yellow and white sand.
14	0	Fine and coarse drift
54	0	Yellow clay with stones.
1	6	Rotten slate.
16	6	Red clay.
8	6	Red clay with stones and slate.
20	6	Red clay with stones.
14	0	Red and yellow clay.
2	0	Rotten or decomposed slate.
192	6	

Fresh water at 32 ft. 6 in., rose 12 feet.
Brackish water at 191 feet, rose 21 feet.

[Ann. Rept., 1886, pp. 201-207; Ann. Rept., 1886, pp. 199-207.]

deposited. Hence clay, sand, and pebble masses may be dovetailed into one another. The gold contents will decrease in value in a very rapid manner once the streams pass from the rock masses to the alluvial plains, partly because of the gradual submergence of the auriferous veins themselves, and partly because of the lack of stream strength required to transport the gold for any considerable distance, and partly, also, because of the instability of the stream channels, the accumulation of gold in pockets being thus prevented. It is evident, therefore, that the bulk of the payable gold will be found along the gutters and "reef rock" of the defined channels, the gold in the body of the higher belts of drift being more finely disseminated, and needing cheaper metallurgical processes for profitable extraction than those at present in general use.

Before concluding this sketch of the origin of the Forbes-Parkes leads an interesting fact of observation may be noted. During the sinking operations at Forbes, along the Caledonian and South leads, the miners passed firstly through a mass of clay, averaging about 40 feet in depth, and secondly through a mass of drift averaging 20 feet or more in depth. Now, in attempting an explanation of such an apparently widespread phenomenon as this alternation of thick beds of coarse drifts and of clay, we must remember that the area under discussion was one of subsidence. As such the occurrence of these thick beds of pebbles overlying clays cannot be explained by assuming the visitation of the area by heavy rains. On the other hand, if the country further to the east should have been raised in the form of a plateau, then the streams would have gained so much in strength by reason of the increased slope of its channel base that deep gorges would have been formed rapidly in the hinterland, and the coarse material derived from such gorge or cañon cutting would have been spread out over the sinking area as a coarse drift or conglomerate. After the gorges had been cut some distance back into the ranges, the channel slopes would have become less pronounced, and sand and clay would then be carried down instead of pebbles.

If now the land should rise gradually after such a great plain had been formed, or if the loads of material brought down by the streams should decrease, as they naturally would do, as the bases of the stream channels were cut down to more gentle slopes, then, as a result, channels would first be formed in the black-soil plain, while at a later period the plain itself would be benched back until only small patches and terraces of it would be left in positions favourably situated as regards their preservation.

We may now sum up the main facts in connection with the history of the Forbes and Parkes leads.

(1) The land was raised and a series of "valley in valley" forms were excavated by the Lachlan tributaries. Along the steep channel bottoms gold was deposited by the rapid streams, for during the process of wearing the country down, the lodes contained therein were also broken up and their auriferous contents "were washed down and lodged in the channels of the old streams."

(2) After the formation of these rock channels, the land sank, and the rock-bound watercourses, instead of being deepened, were at this stage gradually filled up. The gold contents became poorer in these upper alluvial deposits, firstly, because the gold reefs were being buried in part; secondly, because the streams at this stage had not the power to carry the coarser gold as far as formerly; and thirdly,

because the gold was distributed throughout a vast width of alluvial débris, instead of being concentrated near the bottom of a narrow gutter.

(3) After the filling of the well-defined channels, the alluvium began to overflow the rock rims of these old watercourses and to bury the whole lower portion of the main Lachlan Valley. The streams at this stage ran in no well-defined channels, except locally, and gold was naturally jigged and deposited upon the channel sides and false bottoms.

(4) The land to the east of Forbes appears to have risen considerably at this stage, and heavy masses of coarse drift were laid upon the clay and sand beds by the swiftly-flowing streams. As the strength of the streams decreased, the "black-soil" plains were deposited in turn upon the coarse drifts.

(5) After the formation of the "black-soil" plains, the streams commenced to wear these away in turn, until now over great areas in the district under consideration, the plain has been cut away to a depth of from 20 to 25 feet. In these black-soil plains no payable gold deposits occur, because the strength of the streams which made the plains was not sufficient to carry payable gold deposits into the fine alluvium composing them.

This being the general method of the formation of such leads as those of Forbes and Parkes, one is now able to appreciate certain difficulties experienced by the miners in exploiting them. The following extract, taken from various official sources show clearly the disabilities under which the prospectors laboured. The first extract is from a report of Mr. C. S. Wilkinson,* and deals with the question of the deeper ground not being always the most payable. "Such not uncommon occurrences may have originated in various ways; for instance, at the particular time of the deposition of the gold-bearing drifts, the old stream may have been wearing away and distributing as drift some auriferous bed, rock, or quartz reef, which had no great depth, consequently when the river had eroded its channel to a lower level, the underlying rock it then acted upon may not have been auriferous, and therefore the drift derived therefrom would be so also. Again, in Silurian country, there have been frequently noticed belts of non-productive rock, running parallel and alternating with rich tracts, these then, under certain circumstances, would also afford an explanation upon the above-mentioned facts."

Mr. Warden Dalton also frequently refers to the disabilities under which the miners laboured. The following two extracts from "Mines and Mineral Statistics, 1875," illustrate the point well: —

"As the prospectors proceeded with their labours, they discovered that the depth varied, and that long ridges, some containing quartz reefs, lay concealed beneath a level surface. The miners had yet to learn that the deepest ground was not the most auriferous, and every new ridge, or as they designated it, mullock bank, created a demand for a new line. The swinging of base lines was incessant and no little confusion and litigation was the result."—(p. 31).

"At that period the miners sought exclusively for the deepest ground. . . . . Shaft after shaft was sunk and the result was ever the same—wash in abundance and gold, but not payable. The miners burrowed through the deep ground until their means and energy were alike exhausted, and

* "Notes on the Geological and Mineralogical Collection at the Metropolitan Intercolonial Exhibition, 1875." [*Quoted from H. Margules' Ann. Rept. Dept. Mines N. S. Wales for* 1876, *p.* 84].

many had abandoned their areas, when the holders of a claim on the line a mile from the creek, at a depth of 157 feet, bottomed upon good wash in a well-defined channel containing coarse gold. . . . . At last a shaft, sunk at random 100 yards to the east of the old line, bottomed at a less depth, by about 15 feet, on the eastern side of a reef or ridge, and struck the long-sought lead . . . . ."—(p. 37).

In the early days of the Forbes alluvial mining, the "gutters" only were supposed to have been worked, and repeated attempts were made at later dates to locate gold deposits which were supposed to exist upon the channel sides.

"The smallness of the claims (40 feet square, E.C.A.) prevented the application of the machinery and plant necessary to enable the holders to contend with water, quicksands, and swelling schists with any prospect of success. With imperfect appliances . . . . the miners had no thought of reef-wash or benches. . . . ."—(Warden Dalton, Ann. Rept. Dept. Mines, 1877, p. 75.)

About thirteen years after the main Forbes leads had been abandoned, Mr. Phillip Davies (Ann. Rept., 1877) stated that the sides of the channels had not been exploited, and he himself commenced a vigorous prospecting campaign along the South Lead. Nevertheless, all such have proved unsuccessful; 'reef' gold has indeed been found, but not in payable quantities.

"Other difficulties were experienced in tracing the leads into the deeper ground. . . . "The Bushman's Lead crosses the Goobang Creek at a depth of 93 feet, and enters a small circular lagoon about 200 yards in diameter, which is filled with wash-dirt to the thickness of from 3 to 4 feet. . . . . From the lagoon, the Great Northern extends northward in a direction parallel to the course of the creek, but upstream. . . . . There is much doubt as to the course of the outlet from the lagoon."

"Proceeding farther north, we find the Welcome Lead lost in the wet and deep ground where it was most productive—the Bushman's Lead lost in the bed of an ancient lagoon, where it was also rich in gold —M'Guiggan's South and the London Leads also lost in deep ground —and the Ben Nevis workings confined to ledges in the vicinity of the ancient bed of a river."—(Ann. Rept., 1877, p. 76.)

The possibility of the existence of larger and deeper channels than those already known in the district has been often considered by the alluvial miner of Forbes and Parkes. The following extract from Mr. Warden Dalton's report sums up the information on this point in the days when the values of the deep leads were rapidly decreasing:—"The richest portion of the Welcome Lead was that along the margin of the Goobang Creek. From the foot of the Welcome to the foot of the Bushman's, following the course of the creek, is a distance of about five miles, and the deep channel between these places might be traced without encountering more than the ordinary difficulties that attend such operations. It is perfectly clear that all the most auriferous ranges and leads have been surrounded to the southward and eastward by a deep ancient channel that received their drift and drainage: this channel discharged its waters from west to north for at least 12 miles of its course . . ."—(Ann. Rept., 1875, p. 36.)

"These men know that the leads are not exhausted . . . that a channel in the older Tertiary drift crosses the richest portion of the gold-field, and at a depth of 330 feet has not been bottomed—that that channel must

* Mines and Mineral Statistics, 1875, p. 33.

in ancient times have received the local drainage, and that the discovered leads were in all probability tributary to it. Knowing all this, they hesitate to face ordinary mining difficulties that are of common occurrence in other parts of the world."*

In a word, the alluvial miners found that the deepest portions of the leads were not necessarily the richest; that the channels appeared less definite as they reached deeper ground; that the gold contents ceased to be payable—so far as the miner of that time was concerned—after the channels had been followed downstream for certain distances. They knew from geographical principles that the buried channels of Forbes and Parkes must have discharged into main watercourses in the same way, as their surface equivalents do to-day, and they conjured up to themselves visions of deep, broad channels, receiving the local underground drainage and carrying rich gold deposits, which, when found, would give employment to hundreds, or even thousands, of men.

Nevertheless, one will readily observe that there is nothing in the nature of the main watercourses of to-day [such as the Billabong or Lachlan] to justify any expectation of rich gold contents in the main underground watercourses. That these exist is a necessity from geographical principles; but that they contain rich gold deposits is another matter. The present main streams, indeed, contain no payable gold deposits to justify the belief that the main buried watercourses possess rich gold contents.

Now in such a case as this, namely, where the deep underground channels of the district have not been found, the only knowledge one has for one's guidance is that which is based on a knowledge of the surrounding country and the principles of stream action. The miner simply knows that there are deep leads; and that they possessed much richer gold contents than those portions of the present surface watercourses situated vertically above them. He knows, moreover, that these leads must drain into the former main watercourses of the district, and that such old watercourses do not lie immediately underneath the present main watercourses. The problem is: first, to locate the beds; and, after having succeeded in this difficult task, to locate the gold deposits which may exist therein.

Location of Main Underground Channels.

It will be well in attempting any discussion as to the probability of locating rich gold deposits in the continuations downstream of the deep leads, to briefly trace the history of the Lachlan and the Billabong Creeks during the formation of the black soil plains. In recent times these channels have undergone remarkable changes. A glance at the accompanying geological map is sufficient to show one that the present main channel of the Parkes district flows through a wide plain of alluvium of its own making. Past Tichborne its course is south, thence it turns sharply to the west and passes through the comparatively narrow gap formed by Miller's Hill on the south and the Tichborne Hills to the north; thence it advances west and pierces the Jemalong or Coragery Range by means of a narrow gap which has been partially filled with alluvium. The earlier Billabong had a course different to its present one, and it is almost certain that in the near past it joined the Lachlan near the Jemalong Gap. When the district subsided the low-lying country was gradually buried under alluvium and

* Warden Dalton, Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 75.

the bases of certain gaps, which previously had existed above the river level, now, by this process of valley-filling, occupied lower positions than the main stream. Through these in turn the largest streams would pass, as along the lines of quickest descent, each being kept, however, at about a uniform level. Thus the Lachlan at various times has occupied the Marsden, Jemalong, Gunning, and Goobang Gaps indifferently, and the Billabong or Goobang Creek has also joined the main stream now by way of one gap, and now by way of another, sometimes indeed joining it before reaching the notched range of quartzite lying from 12 to 15 miles west of Forbes and Parkes.

In the neighbourhood of Parkes and Tichborne the alluvium is several miles wide. The hills extending from Parkes to Tichborne shut in the old channel on the west, while the long low flinty range about four miles distant to the east, formed a wall to the Billabong Valley on that side. It is true that this eastern wall is breached by several alluviated gaps, any one of which, upon casual inspection, appears competent to have allowed the Billabong to escape in that direction in former times. The most important of these gaps is that now traversed by the Molong Road and the Upper Goobang Creek in its course to join the Billabong. The Goobang, however can be seen pouring over a rocky ledge where it has cut through the overlying alluvium, so it is evident that the old Billabong Creek could not have passed out that way to the east, because the alluvium exceeds 100 feet in depth to the immediate west. Similarly, it is doubtful whether any of the more northerly gaps in this belt (see map), and now alluviated, were low enough in recent times to allow of a passage first east and thence south for the Billabong to the Lachlan. On the other hand, the present valley of the Billabong, with its broad black-soil floor, is of just such dimensions as would suggest its formation by an important stream like that of the Billabong. One may then rest fairly well assured that the old Billabong Creek flowed south beneath the broad belt of alluvium as shown on the map, thence turning at right angles and flowing west past Tichborne but at some distance to the south of its present position. At Parkes it is almost certain that its old course was some distance to the east as also south of its present position at Tichborne. This may be proved in two ways. In the first place the Billabong Creek has been drawn over to the rocky walls of the valley between Parkes and Tichborne during the burial of the country under alluvium, whereas at the period that it was excavating a channel in the rock floor of the old broad valley, it is almost certain that such new channel would not be developed against the gently-sloping wall of the valley. In the second place the arrangement of the known channels of its tributaries, such as the Great Northern, the Welcome, the Tichborne, and the M'Guiggan Leads, show that the old underground watercourse must have lain farther to the east at Parkes and to the south near Tichborne.

Less is known concerning the course of the old Lachlan River. It is certain that in earlier times it must have flowed farther to the south, because during the alluviation of its broad valley it has been crowded northwards to the low rocky wall on which stands the township of Forbes.

An interesting fact may be noted in connection with these old deep-buried watercourses. The deepest portion worked along the South Lead was that almost immediately underneath the present Lachlan River. This was not deeper than 225 feet, whereas Mr. C. S. Wilkinson* mentions the existence of a deep lead from 300 to 400 feet deep at a spot about a mile north-west

* Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 160.

from the town of Forbes. It is described as of Older Pliocene age, and as passing about half a mile west of the town. Mr. Warden Dalton evidently refers to this lead* when he mentions the occurrence of "a channel in the older tertiary drift" which crossed the richest portion of the gold-field, and had not been bottomed at a depth of 330 feet, and a channel which "must in ancient times have received the local drainage." Although the old shaft on this lead has now fallen into disrepair, I am informed by Mr. Hasemer of Forbes, that this lead is generally reported to be 500 feet deep. A shaft appears to have been sunk on a mass of coarse drift, capping a hill lying about $1\frac{1}{2}$ miles to the north-west of Forbes. At a depth exceeding 100 feet the "high bar" was met with; a drive was put in thence towards the centre of the channel and a monkey shaft about 200 feet sunk, which also bottomed on the high bar lower down. Other monkey shafts were put down until a hard cement was broken through at a depth of about 500 feet, when a great rush of water occurred, forcing the miners out of the workings. This was either in 1861 or 1862.

Although the brace of the shaft lies about 150 feet above the present river level, it will be seen that the bottom of the gutter just described lies at a much lower level than the deepest point yet proved along the South Lead. The physiographic evidence, however, does not go to show that this buried watercourse received the drainage of the leads at an earlier date, but rather that it was an independent tributary to the Lachlan at a time when the latter stream flowed farther to the south and occupied a position many hundreds of feet vertically below that which it occupies to-day. Anyone who considers that the deeply-buried watercourse just described is the buried Lachlan River must account for the excessively narrow channel which the river must have occupied while such a magnificent valley existed to the immediate south through which it might naturally be expected to flow. The peculiar course the Lachlan would have had to follow so as to enable it to get into such a narrow defile so far to the north would also be difficult to explain.

(2.) *Probability of payable gold being found in the main buried channels.*—Several points need consideration in this connection. Firstly, there are the relative steepnesses of slope which exist among the channel bases; and, secondly, there are the relative sizes of the auriferous area and the catchment area of the main stream traversing the former to be considered. It will be advisable to consider these, and to apply the results obtained to the case of the Forbes-Parkes District.

(*a*) *Slope of channel base.*—Gold may be easily carried down for long distances on a steep channel base, whereas on a negligible slope the gold contents lie practically inert. We may now apply this test to the gutters of the deep leads of the district.

Forbes.—The gutter of the South Lead is steep, and falls about 200 feet in a run of about 2 miles. Rich gold deposits occurred along the gutter until the lead passed vertically beneath the present Lachlan. Large boulders were plentiful in the channel. It is certain that the old buried channel of the Lachlan, into which the South and Caledonian Leads empty farther down-stream, did not possess the same decided fall. Probably they did not possess grades steeper than from 300 to 400 feet in a traverse of from 30 to 50 miles.

* Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 75.

Parkes.—The Welcome, M'Guiggan, and Great Northern Leads certainly commence with steep leads, but at short distances beyond their disappearance under the alluvium they lose their distinctive channels. For example, the Bushman, or Great Northern, spreads out into sandy patches at the point where it passes vertically beneath the Billabong Creek. At this point the gold values have also appreciably depreciated; and from an examination of the official records, the idea is gained that the channel base has grown too broad and sandy to follow, even at this short distance from the feeding reefs in the Parkes township itself, and that the gold values have become decidedly poorer. A similar state of affairs was revealed by mining operations along the Welcome, M'Guiggan's, and London Leads. In addition to this, from the principles of geography, one knows that in a district such as that of Forbes and Parkes, the old buried channel base of the Billabong Creek was less steeply inclined than those of its feeders. If it depended, therefore, for its gold contents upon the enrichments obtained from its tributaries, such as those here enumerated, one would not expect to find payable deposits along its base.

It appears strange, however, that such well-defined channels as those of the tributary leads we have just mentioned should pass into the flat sandy bottoms mentioned in the official records at such short distances from their sources, and were the skill of the Parkes and Forbes miners not so well known, one would think that here a false bottom had been mistaken for the bedrock.

(*b*) *Relative sizes of the catchment area of a stream and the area of a gold belt drained either by a tributary of the same stream or by the stream itself.*

This is a most important point for consideration, since it does not necessarily follow that the bed of a stream must contain payable gold simply because the stream itself traverses a belt of auriferous country. For, suppose a case, where an auriferous area is drained by small tributary streams which flow into a large watercourse, the drainage area of which is large as compared with the auriferous area traversed. We may assume, also, that the tributary streams just mentioned all contain payable alluvial gold, especially along their upper and steeper portions, but that along their more sluggish portions near the points of their intake by the main stream, they are scarcely payable, owing to the lesser concentration of the gold contents at such points, the lack of concentration being due, we will suppose, to the breadth and flatness of the channel bases. All other things being equal, the main channel, however, which drains an area very large as compared with that of the auriferous belt, has both a correspondingly large channel and mass of channel drift in which to distribute an equal amount of gold as that which occurs in the smaller channels. Under these circumstances one may expect to find gold deposits behind rock bars and at certain points opposite to, although slightly down-stream, of cutting curves, but the volume of the water of this main stream in flood-time will carry the fine gold down-stream for many miles and distribute it sparingly amongst its masses of drift. In a case such as this a payable deposit of gold may be found at an incredible distance down-stream, because the stream has transporting power sufficient to carry the gold down until a peculiarly favourable lodgment is found. On the other hand, since the amount of gold available for the whole stream is only that brought down by the tributaries, which themselves in turn are almost unpayable as they join the main stream, then in such a case the main channel may be classed as unpayable since the cost of the search for such isolated patches is altogether too great. An instance of such action is mentioned by Mr. J. E. Carne,

Assistant Government Geologist, for the Upper Hunter River at Denman. Here prospectors found gold in the bed of the river and immediately proceeded to prospect the rocks in the vicinity, although it was evident to the geologist that the nearest belt of auriferous country lay many miles up-stream. In this case the Hunter floods had been so strong that alluvial gold had been carried for many miles down-stream and deposited at a spot specially well protected from stream influence. Nevertheless, the Hunter itself for many miles above this point contained no payable deposits of alluvial gold.

If the auriferous area, however, which is traversed be a large portion of the catchment area belonging to the main stream, and if at the same time the gold contents be exceedingly rich, then large payable deposits of alluvial gold may be expected to occur for miles down-stream. An example of this appears to occur along the Macquarie River channel and banks below the point of intake of the Turon River. In this case the country all around Hill End, Sofala, and Wattle Flat has shed great quantities of gold into the Turon (a powerful tributary of the Macquarie), which in turn has carried a large percentage of the same into the main stream, along which for many miles towards Wellington rich gold deposits have been deposited.

In this connection it will be advisable now to ascertain, if possible, the geographical and other relations existing formerly at Forbes and Parkes. In these localities the auriferous areas are confined to a narrow strip arranged along a north and south line. At Forbes the gold belt is very narrow, but doubtless it extends a little farther to the east underneath the alluvium. At Parkes the belt is somewhat wider, but an examination of the district shows that its eastern extension underneath the alluvium is very limited in extent. Furthermore, the bulk of the Billabong catchment area is away from the auriferous area. Not only is this so, but the ancient course of this stream was also practically east of the gold belt—that is, the Billabong itself traversed a small portion only of the gold belt, but relied, in the main, for its gold contents upon the material brought down by its tributaries. Similar reasoning may be extended to the case of the Lachlan River and its northerly tributary under the alluvium near Forbes, into which the King, Queen, Bald Hill, and other leads emptied.

At Parkes, again, the small buried watercourses known as the Welcome the M'Guiggan, and the Great Northern ceased to be payable (under conditions existing at the time) before they even effected junctions with the Billabong. Nevertheless, only these small streams flowed over the rich gold belt. One would hardly expect the main channel of the district to be payable under such conditions; for in the first place it drains an area much larger than that of the Parkes gold belt, and for that reason alone its gold contents must be more scattered than are those of the streams confined to the belt; in the second place, the very tributaries upon which it depends, in the main, for its gold supply are not payable, apparently, as they leave the gold belt; and in the third place, the main channel evidently possessed a broad, shallow valley, and this would imply lack of concentration of the gold along its base. One would thus expect to find along such main buried channels:

(1) A preponderance of unpayable drift.

(2) Isolated patches of payable gold just below the points of intake of such tributaries as the Bushman, the Welcome, and the M'Guiggan South.

Similarly, the old main channel into which the Caledonian and South Leads of Forbes discharged may be expected to possess several pockets of payable gold in sheltered spots just below the points of intake of the tributaries.

The following notes may be found of use in the event of any future prospecting campaigns :—

(1.) *Forbes.*—(*a*) The flat immediately east of the Lachlan line of lode may contain a payable lead; a row of bores across the flat, and lying some little distance to the east, should reveal the presence of such, if existent. Thompson's Lead has not proved the lead far enough to the north, and the Bald Hill Lead is far to the north of the lowest portion worked of the Thompson's Lead.

(*b*) The Britannia Lode disappears to the south under the alluvium. Although the outcrop has disappeared, nevertheless the lode doubtless persists under the surface in this direction. It is well known that certain leads have been enriched by the gold shed from this auriferous line, and it is probable that other leads have been enriched to the south.

Again, it is evident that the South Lead must have received enrichments from the Britannia, and as this line was not buried during the formation of the South Lead, it is highly probable that rich deposits have been deposited from that source on the "rim rock" or the channel sides of the South Lead.

(*c*) The Lachlan River, now buried, may contain a rich deposit just below its point of intake of the South Lead. This, however, could only be expected if the old Lachlan River flowed much to the south of its present position.

(2.) *Parkes.*—In this district attention should be directed to following the tributary leads down-stream rather than to a search for the old main channel. If the tributary leads are found to become unpayable, we can hardly expect good returns from the main channel when the latter depends upon these tributaries for its gold contents. A simple comparison with the present condition of things there will help us to understand this point. The shallow leads of Parkes paid very well until they left the gold belt and entered the alluvial plain. There the gutters became too flat, the channels too unstable, and the drift too fine and too great in quantity to allow of profitable mining along those channels. Furthermore, the main present Billabong channel appears to have no payable gold deposits along it. Of course, this analogy must not be strained so far as to say that because the present shallow leads paid while traversing the gold belt, and that both they, as well as the present Billabong channel, contain no payable deposits while crossing the alluvium, therefore the old buried Billabong channel will contain no payable gold. Nevertheless, the analogy may safely be carried this far, namely, that there is much less chance of finding payable gold in the old main buried channel than in its buried tributaries, such as the M'Guiggan and the Bushman. Therefore, if these tributaries become unpayable when followed down-stream, we may rest assured that unless some unexpected lode has been crossed by the main stream, then it is idle to expect payable gold to occur therein.

When one looks to leads in other districts, one sees that this is so. Theoretically also, it must be so from mechanical considerations. Thus the Eucumbene River at Kiandra was payable as it traversed the narrow gold belt, but it became unremunerative immediately below that belt. Had the Eucumbene here possessed a large catchment area as compared with that of

the gold belt at Kiandra, it is doubtful whether even at this spot it would have contained payable alluvial deposits. The case of the Hunter, cited above, is another instance. The Shotover, in New Zealand, at first sight appears to be a remarkable exception to this rule. In this case, however, the stream traverses an auriferous belt of enormous area. The Macquarie River, below the point of intake of the Turon, is also another example of a main stream enriched by a powerful tributary, which has carried great quantities of gold into it.

(3.) This chapter on the leads may perhaps be fittingly closed with a page or two descriptive of the methods formerly adopted in taking up the ground, and of those adopted in the working of the same.

According to Mr. Richard James Barton, of Forbes, the Gold Commissioners allowed only 10 feet per man along the width of the South Lead. At a later period, areas 40 feet square were allowed to each party of four. It will be seen at once how such a system practically prohibited the expenditure of much capital in working the claims. The ground was wet, yet each small party, in ways best known to itself, had to contend with heavy water, with swelling bottom, and with running ground. Each party worked with frantic haste, so as not to be left to contend singly with the water. One serious difficulty arose in the process of sinking through the course drifts, which averaged from 15 to 20 feet in thickness, and which occurred generally at a depth of about 40 feet from the present surface. These were saturated with water, and the greatest difficulty was experienced in sinking through them to the underlying impervious clays. If the alluvial miner could sink and secure his shaft through these unstable structures and regulate it so as to prevent the water from seeping down it to the workings below, he could work the gutter in comparative dryness and comfort. After repeated failures, recourse was had finally to a method of sinking through the watery drift with watertight boxes shod with iron. These were then anchored firmly into the impervious clays beneath, and the space between the box and the drift puddled so as to be watertight. Sometimes "box-in-box" structures were employed in sinking through the drift, and the services of professional divers were also sought in this connection.

With the progress of time attempts were made to help the alluvial miner in various ways, notably by granting larger claims. One of the later systems of leasing the ground may be here briefly described. Alluvial ground was leased either in block or in frontage claims. If the ground was less than 100 feet deep it was leased in block claims, while under the frontage system each party was allowed a frontage of a certain length and width along the gutter when the deepest point of such gutter lay 100 feet below the surface. Inasmuch as the course of the lead could only be known approximately at points either immediately below or above any point at which it had been located definitely by the prospectors, the direction in which the lead would run was assumed, and frontage lines along that line were designed. As the gutter was proved by the prospectors so this frontage line was swung sideways and the side claims were adjusted at the same time. The only condition for holding claims by this arrangement prior to pegging out was by employing someone to watch or "shepherd" the claim for two hours a day.

220 feet square was a common size for a block claim.

Naturally, such a system as that of the frontage had its own particular disadvantages and was productive of much dishonesty. The following graphic account of the deplorable results which accrued from the employment of such a system is taken from Mr. Warden Dalton's report in "Mines and Mineral Statistics" (1875, p. 31).

"As these leads became gradually developed and were traced to the margin of the creek (Billabong Ck.—E.C.A.) . . . it was clear that the present channel of drainage had been formed subsequently to the denudation of the hills . . . , and that the bed of an older stream must lie farther to the southward and be covered by the alluvial deposits that stretch towards the Lachlan River, . . . adventurous prospecting parties crossed the stream, and extended their operations to within a few miles of Forbes; they were followed by hundreds of shepherds who occupied long lines of imaginary leads in anticipation of the red flag. Land speculators also followed like sharks in their wake, and suddenly discovered that a waterless country that had been permitted to lie unoccupied by permanent settlers up to the present time was the only place where they could select homesteads. . . .

"As the prospectors proceeded they discovered . . . that long ridges lay concealed beneath a level surface. . . . Every new ridge created a demand for a new line. The swinging of base lines was incessant, and no little confusion and litigation was the result. In fact, the operations of the miners on these wide levels appeared more like the evolutions of an army in the field than anything else—marking claims had resolved into a game of chess."

Gold Yields of Leads from Forbes and Parkes.

Forbes, 1862–1864.—Between these dates the famous South and Caledonian Leads, with their tributaries, yielded over 300,000 oz. of gold.

Parkes.—Between 1871 and the close of 1873 the Parkes leads (No Mistake, Great Northern, and Welcome Groups) yielded about 50,000 oz. gold.

From March, 1874, until the close of 1879, the Parkes leads (London, Tichborne, Wapping Butcher, and M'Guiggan Groups) produced about 156,000 oz. gold.

B. Quartz veins associated with intrusive andesites.

These include the Britannia, the Lachlan, the Nil Desperandum, the North Lachlan, the Federal, the Nibblers, the Koh-i-noor (?), the Buchanan, the Phœnix, the Bonnie Dundee, the Bushman, the Pioneer, and the Dayspring veins. A number of minor veins are to be included also in this list, such as those which were found within the township of Forbes itself, and those which occur along the line from Miller's Hill (Tom's Knoll), at Tichborne, to the Dayspring Mine, lying about 2 miles north of Parkes. A glance at the map reveals the fact that all the auriferous deposits just enumerated occur either in or alongside of a long north and south line of compact augite andesites, the strikes of the igneous and associated sedimentary rocks being practically coincident. At times the veins either follow the junction of the andesites with the sediments, or they cut across the line of strike of the igneous rocks. Those in the former class are the longer veins. Of these, the Lachlan and Buchanan Lines are good examples, while the Bushman and Phœnix Lines are typical members of the cross veins. Although these veins appear to be so intimately related to the associated andesites, nevertheless the latter themselves have been intensely altered in many places by the auriferous solutions. Thus clouding of felspars, development of abundant pyrites, and more or less complete replacement of andesite by quartz and

ferruginous material, are common features over considerable distances alongside the fissures. These observations prove that the andesites themselves did not bring up the gold values, but that they either—

(1) Fractured and so heated the country that waters were set in circulation which leached out gold from the crumpled Ordovician (?) sediments of the district and deposited them along lines of shrinkage developed in turn by the cooling of the andesites; or—

(2) Cooled and contracted after intrusion of the pre-Silurian sediments and thus made way for the ascent of plutonic waters given off by the same underlying hot magma as that of which the andesites in turn have been but a secretion. These circulating waters may have obtained their gold contents either from the magma itself or by a leaching process from the associated rocks in their upward movement.

Another possible explanation for the quartz veins of this class is that they were derived in part from the underlying magma and in part also from the other rocks associated with the andesites.

In any case, here, as at all other places observed by the writer in New South Wales, gold deposits have arisen as direct introductions by circulating waters (or water and gas) and not as segregations from the associated igneous masses during the cooling of the same. Gold has been reported as occurring in unaltered granite, rhyolite, and other igneous rocks in New South Wales, but in each case it may be seen to have been introduced by foreign water, which has either replaced the associated igneous rocks in part with its own dissolved material, thus giving rise to deposits such as mica, pyrites, calcite, quartz, and gold, or has deposited quartz and gold along thin joint faces of rocks in localities of heavy faulting. Timbarra and Grassy Gully are examples of the former action, while certain of the Yalwal gold occurrences are examples of both classes of action.

In each case, also, the solutions from which the gold has been precipitated cannot be shown to have possessed any direct connection with the associated igneous rocks.

The cross veins, it has been mentioned, lie almost at right angles to the general line of strike of the andesites, and they appear to be depositions along cross-cracks due to the cooling and the consequent shrinkage of the intrusive masses. As the mining workings were inaccessible during the time of the geological survey of the field, the relations of the strike and cross veins are not known, neither is it known whether any of the veins themselves have been intruded by dykes later than the general andesite mass. The Bushman Line would be a good locality to examine in this connection.*

Class of Veins.—The veins, whether of the strike or of the cross variety, most frequently represent fillings of fissures; nevertheless, a considerable amount of replacement of the country has taken place alongside of the original fissures. By this process of replacement large chambers, such as those described in the chapter on the Lachlan Lodes, were formed at the expense of the country rock. The Britannia Lode appears to contain large replacement bodies.

Ore Associates.—The minerals associated with the gold are quartz, iron, and arsenical pyrites, fahlore (Dayspring), and calcite, with small quantities, at times, of copper and galena. The quartz may be white, compact, opaque, transparent, or ferruginous. Again, it may be pyritic, cellular, and brecciated. The brecciated appearance is frequently due to the percolation of silica solutions along a set of tiny branching cracks, and to a gradual

* Since writing the above, Mr. J. Wann, Manager of the Bushman Mine, assures me that an andesite dyke has cut through the line of the Bushman Lode proper.

replacement of the walls of these cracks by the silica ; the cessation of activity in the replacing solutions during an early stage giving rise to the appearance of breccias.

The cavernous nature of the quartz of the veins is most frequently due to the leaching out of the pyritic contents of the quartz. Water level is found in the Forbes–Parkes district at depths varying from 75 to 150 feet from the surface, and above this level the quartz is frequently ferruginous and cavernous, while below that level the quartz contains an abundance of both iron and arsenical pyrites. In Boyle's Mine the arsenical pyrites occurs in large irregularly-shaped pieces, very fine in texture and very tough in character.

Ore Values.—Owing to inability to examine the underground workings of these mines, the writer, in attempting a satisfactory account of the genesis of the ore-bodies, has been compelled to rely upon the information derived from an examination of the surface geology, of the ore fragments raised, of the "mullock tips" at the various mines, and of the plans and official records of the mines.

One interesting fact may here be mentioned. In some of the "spoil heaps" from the Lachlan lodes, the writer has seen an abundance of carbonaceous or graphitic slates. The occurrence of this material in such abundance and in such connection suggests that it has had some influence on the precipitation of gold along this line of lode, since somewhat similar andesites, occurring in hard jasperoid strata in the neighbourhood, do not appear to contain payable gold lodes.

Several brief notes which were made on the lodes in the earlier days of the field may be here reproduced.

"During 1862, 1863, and 1864, the Billabong was celebrated for its quartz reefs. Nine of these were worked efficiently. Near the surface the produce was from 2 to 3 oz. of gold per ton of stone ; this gradually decreased until at the depth of 150 to 180 feet a change in the investing rock occurred; below this the respective mines did not pay the expense of working, when the place was abandoned."*

"In 1862, as well as 1872, the Billabong Gold Field gave some considerable evidence of the existence of rich quartz reefs within its boundaries . . . . but in each decade quartz workings were of short duration only.†

"Between the dates October, 1862, and December, 1867, the lodes of Parkes yielded 40,000 oz. of gold."‡

"Many of the reefs that have been tested contain a small quantity of free gold associated with arsenical pyrites and galena, the latter in small quantities. Near the surface these components are more or less decomposed, and the sulphurets are replaced by peroxide of iron, and when this decomposition has taken place, free gold may be more frequently observed. As the reefs descend decomposition ceases, and in some instances free gold disappears. The decomposition may be due to the percolation of rain-water from the surface, and may extend no deeper than it can penetrate. This may account in some degree for the fact that the reefs of this district have always proved to be most productive near the surface or in the immediate vicinity of an intrusive dyke between which and the originally softer rocks that form the walls of its fissure, water charged with carbonic acid, soda, chlorine, and other chemical agents may find its way to a great depth."§

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* Warden Dalton, Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 80.
† Margules, Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 89.
‡ Extract from Warden Sharpe's Report, (Prospecting Board, 87/15730).
§ Warden Dalton, Ann. Rept. Dept. Mines for N. S. Wales 1875, p. 39.

From these extracts it is evident that the earlier mining men ascertained the upper portions of the veins at Parkes and Forbes to be very profitable, but it is also evident that below a depth of 200 feet they considered them to be unprofitable. Later prospecting campaigns along these discarded lines of lodes, however, have shown the latter idea to be erroneous. One has only to mention the revival of mining operations along the Koh-i-noor, the Bushman, the Buchanan, the Bonnie Dundee, and the Dayspring Mines to show the fallacy of the idea that this is a "worked out" field.

It is difficult, in the present state of our knowledge, to account for the cause of the ore enrichments. Mr. H. Hooke, Government Mining Inspector, refers those of the Bushman Lode to the influence of "droppers," or subsidiary veins, and he states the occurrence of at least two shoots. Mr. J. E. Wann, a former manager of the Bushman Mine, says that the "shoot" of the Bushman was about 700 feet in length, near the surface, and that it had a pitch to the west, the values decreasing from several ounces to each ton of stone treated between the 300 and 400 feet levels to about $7\frac{1}{2}$ dwt. at a depth of 900 feet. Both the Birthday and Buchanan lines of lode are said to possess distinct shoots of ore having dips more or less vertical. The writer often seen the vein below ground.

Only one belt of Andesite related to the Lodes.

An interesting point in connection with the veins under consideration is their apparent dependence upon one belt only of andesites. A glance at the map will show that Grenfell, Forbes, Parkes, Alectown, and Tomingley lie practically along the same line of strike. In the middle section of this stretch of country, 100 miles in length, the present survey has revealed the absolute association of the two, the andesites appearing to stand in some causal relation to the gold veins. The following quotation from a report of Mr. C. S. Wilkinson is instructive in this connection:—"With but few exceptions I have noticed that on all the gold-fields recently examined, hornblendic granites and intrusive greenstone or diorite are the original source, whence the gold found in the alluvial deposits has been derived. At Grenfell this is very marked. There we have a very large mass of porphyrite intruding upper Silurian schists. Quartz reefs, varying in thickness from that of a mere thread to over 10 feet, traverse the intrusive rock in a north-easterly direction, and in some instances pass into the adjoining schists; but though richly auriferous while on the former rocks, they cease to be so immediately on entering the schists."*

The schists Mr. Wilkinson refers to here are possibly the equivalents of the schistose slates of the Forbes–Parkes gold belt.

Again, Mr. Danvers Power mentions the intimate association of the gold at Tomingley with compact andesites, the lustrous slates of the district being of Ordovician age.

Of all the andesite belts of Forbes and Parkes, however, the gold appears to be intimately associated with one only; for with the much larger masses east, west, and north of the one under consideration, no payable reefs appear to be associated. From what has been said, however, on a previous page, it is possible that the gold values are also due in part to the presence of graphitic or carbonaceous slates and schists.

C. *Auriferous Quartz Bodies arranged along Zones of Crushing.*

To the west of the long north-and-south line of intrusive andesites lie various zones of crushed material which are at once parallel to the andesite

* Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 89.

line, to the general strike of the pre-Silurian sediments, and to the planes of cleavage in the latter. Within these zones the rocks have been altered in places to schists. The weaker rocks only, such as the shales, have been cleaved and crushed; the indurated claystones and the thicker of the cherty bands, on the other hand, have not been cleaved, but have been crumpled, the bedding planes being revealed in recent excavations.

The most definite line of such crushing is that along which the Magpie, the M'Guiggan's, the Victoria, the London, the Newhaven, the Band of Hope, the Mount Morgan, and the Strickland (Parkes) lodes occur. The lodes just enumerated lie in a wide zone of alteration. All traces of bedding planes are practically obliterated except at spots where coarser sediments are associated with the more finely-textured ones, and a highly-cleaved appearance characterises the rocks of the zone. A belt of contemporaneous andesitic lava flows accompanies the belt in part (see map), and these lavas possess a banded appearance in places, while they present a crushed appearance in others, as at the Mount Morgan and Strickland Mines. In this general zone of alteration are evidences of parallel lines of more intense crushing. The London Lode may be taken as the type. In this example the ore-body is arranged parallel to the strike of the associated sediments. It varies considerably in width, and it appears to consist of a series of large lenses of ore arranged along a line of crushing. The mining operations in the London Mine appear to have been confined to the winning of one of these lenses. The lens itself is not composed of solid quartz, but is built up by a whole series of small lenses similarly shaped and similarly arranged to the mass of the ore-body itself.

The small lenses which form the texture of the main one lie packed closely together with their vertical axes all parallel to each other. Their surfaces, moreover, curve harmoniously with the bent cleavage planes of the country. The cement of the quartz lenses is of crushed slate, and the gold values appear to occur rather in the cementing material than in the quartz. The accompanying text figure explains the method of occurrence.

From these observations it is evident that the veins of this type were formed at considerable depths below the earth's surface, and that they were formed during the movement which so powerfully affected the country. As the rocks underwent gradual strain and change, solutions containing silica and gold appear to have gradually replaced the country. The peculiar lenticular appearance of the quartz masses and their surfaces, which curve sympathetically with those of the country, may be simply explained. For in a region

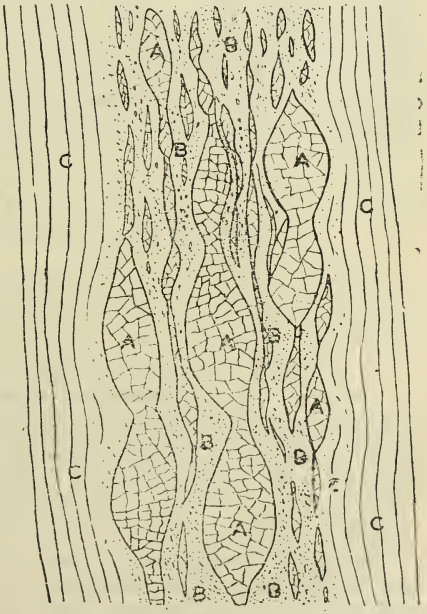

Fig. 5—Sketch section of London ore body near southern end of open cut.
A—Quartz lenses.
B—Crushed slate infilling with films of graphitic material. The cementing material is said to contain higher gold values than the quartz lenses.
C—Cleaved slate country.

where great pressures are present, it is evident that the heat of the wandering solutions may be considerably higher than that of boiling water under ordinary atmospheric pressure. Increase of pressure in such a solution also generally increases its solvent powers, while similarly decrease of pressure generally decreases its solvent powers. Thus under conditions of great pressure, the end of a crystal or granule of country will tend to be dissolved in a small degree by the wandering solutions, whereas upon the pressure being slightly relieved, as at the forward end of the crystal or granule, a portion of the material in solution will be redeposited. In this way a crystal may be continually dissolved and redeposited, and may even appear to grow at the head, while at the same time it is being continuously dissolved at the rear. An analogy may be found in the action of water on masses of sand in a stream-bed. Thus a stream may cut into a mass of sand at its upper end and deposit it in part on the nose, or point of least pressure. In this way a cigar-shaped forward end may often be seen on a sand mass, the nose so formed travelling down-stream. Without straining the analogy too far, one can see how a lenticular mass of impure quartz may thus be formed from a nucleus of slate or similar rock. The end result is seen as a mass of quartz lenses cemented by crushed slate.

It may be interesting at this stage to discuss the relationship, if any, existing between the veins associated with the andesitic intrusions and those associated with the shear planes or zones of strain. Upon examination each appears to have a fairly deeply-seated origin; each group is apparently absent from the neighbouring Silurian sediments, and each appears to be related to the strong earth movements which folded and cleaved the associated sediments. It is probable that the strong earth movements just mentioned gave rise to strong shearing and faulting action, with the production of quartz reefs, and that, at a slightly later date, the andesites ascended along one such long line of weakness. These in turn became consolidated, and after a brief interval of time heated waters rose alongside these igneous masses, and formed the well-known lodes of the field.

DESCRIPTIONS OF MINING WORKINGS.

A.—The Leads.

(*a.*) Forbes.

i. The South Lead Group (South Lead, North Lead, Madman's, Grassatt's and Britannia Leads.)

The South Lead, with its continuation the North Lead, was not only the first, but also one of the most famous deep leads known in the history of gold-mining in New South Wales. During the period embracing the years 1862, 1863, and 1864 both it and the associated deep leads were energetically worked. The claims were so small (40 feet square) as to prevent the erection of machinery competent to cope with the water, the running ground, and the swelling bottoms encountered. In such dangerous grounds miners were dependent in great measure upon the proximity of other working claims to keep the water down. Having also before them the prospect of winning very rich dirt from the centre of the gutter, they would not waste time in dangerous ground which yielded only from half-an-ounce to an ounce per ton of dirt. "Strenuous efforts were made by each party to get their share

of the gutter worked out before that of the adjoining shareholders, fearing that if these men worked out and abandoned the lead before they had secured the best of their wash-stuff, they would lose it; as they knew that single-handed they could not cope with the water and other obstacles that were known to overlay the auriferous drift."* In 1877† it was supposed that the sides of the gutter had not been worked, and a proposal was made by Mr. Phillip Davies to work it with the aid of powerful pumping machinery. Mr. Davies pointed out the disabilities under which the original prospectors of the South Lead had striven, and how that the very remunerative ground only had been worked. It was certainly known that at depths increasing progressively from 110 to 150 feet, eighty-two consecutive claims had struck payable gold; it was known, moreover, that a large gold reef, called the Britannia, had enriched it along its lower course.

In the early days the miner was accustomed to sink a shaft into the alluvium. At a varying depth below this an old river drift containing much water was encountered, while below this drift a thick layer of impervious clay was found to exist. Much difficulty was experienced in carrying the shafts dry through the drift into the underlying clay. They were usually carried down through the drift in the form of boxes, either with or without the aid of divers; the spaces between the boxes and the walls being tightly packed, and the box then securely anchored into the dry underlying clay band. A dry shaft was thus secured.

About the year 1876 attention was directed to the advisability of re-working these old alluvial gutters, and in 1877 Mr. Phillip Davies estimated the cost of winning the wash-dirt as not exceeding 10s. per load.

As a result of these representations the South Lead Gold-mining Co., Ltd., was formed for the purpose of working 50 acres of old and abandoned ground at the lower end of the South Lead, on the Lachlan River, at Forbes. Control of more than half-a-mile along the gutter of the "lead" was secured, and the management was entrusted to Mr. Davies. The old shaft was repaired and enlarged, a water lodgment constructed, and the shaft was sunk 30 feet deeper. A large chamber was opened out; 300 feet of lower main levels were driven, and 1,500 feet of drives in wash-dirt were completed. From these drives 900 tons of wash-dirt were won, which yielded 204 ozs. of gold.

The mine was fitted up with two steam-engines, each of 18 horse-power, and with two Cornish boilers. A puddling engine was employed to drive two cast-iron puddling machines, elevated 24 feet from the surface, besides working a surface pump to supply the sluice.

This mine made water at the rate of 50 gallons a minute. The wear and tear on the winding-engine ropes was found too great, and when, at the close of 1879, the South Lead Company's mine was swamped out, there were added to the plant a 16-inch cylinder pumping-engine and a boiler 22 feet long, as well as a set of cast-iron pumps of 8 inches diameter. The water was raised from a depth of 247 feet.

The company extended their underground workings—chiefly north and west—by means of underlevels, and by such methods the South Lead gutter was ascertained to exceed 350 feet in width, forming a well-defined bed of auriferous wash-dirt averaging 2 feet 6 inches in thickness, and varying from 3 to 10 dwt. a load.

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* Warden Dalton, Ann. Rept. Dept. Mines N. S. Wales for 1877, p. 75.
† *Op. cit.*, 1877, p. 82, 87.

During the year 1880 it was seen that to work this extensive lead successfully it would be necessary to thoroughly drain it. A scheme was therefore devised to raise an additional £20,000 capital, so as to sink a new shaft and attach thereto another large pumping plant. No money being forthcoming, however, mining operations were abandoned.

In December, 1881, the mine had been idle for twelve months, and although shareholders urged the need of prospecting for side-leads, the machinery was allowed to fall into disrepair.

In spite of this failure to work the South Lead at a profit, another determined effort was made to exploit it during the year 1886. Three companies took up claims, namely, the Nil Desperandum Gold-mining Company, the Crinoline, and the Forbes Alluvial Gold-mining Company.

The following description of the efforts made by these companies to win the gold of the South Lead has been copied from the official records :—

"The Nil Desperandum Gold-mining Company holds three leases of 25 acres each in area, and embracing each side of the river. The main shaft is 215 feet deep to the wash-dirt, and a further depth of 20 feet to the bottom. The main drive is 284 feet long, west of the shaft, with a cross-drive 50 feet from the shaft, bearing north 78 feet; east drive 120 feet from shaft, driven 90 feet; north drive 150 feet from shaft. At this point two cross-drives were opened out east and west—the east drive 96 feet, the west drive 82 feet. These last drives are on payable gold. For 140 feet of their length the wash-dirt is from two to three feet in thickness, and averaged 6 dwt. to the load for about 120 loads.

"The machinery employed on this mine consists of a 20-horse power horizontal steam-engine, for winding and puddling : also two Tangye pumps; 28 men are employed on the mine at present, in three shifts of eight hours each shift.

"Coming north, on the same lead, is the mine known as the Crinoline Gold-mining Company. This company holds two extended claims. Their main shaft is sunk 160 feet to wash-dirt, through 35 feet of sand drift. For getting through the drift, 40 feet of watertight boxes of sawn timber were used at a heavy cost.

"The third claim at work on the South Lead is that called The Forbes Alluvial Gold-mining Company. The area is 25 acres. The main shaft is sunk 30 feet to sand drift, 35 feet through that, and then 12 feet to bottom. In this mine also water tight boxes had to be used, the men working in a diving-dress. The machinery to be used in this mine is one 16-horse power portable engine, one Tangye pump, puddling machines, and winding gear. To get through the drift the boxes used are single, and all the sand drift had to be raised by divers, using the proper dress for the purpose. The drift to be gone through was 45 feet in thickness."*

All of these mines were taken up over old and abandoned ground. The Crinoline appears to have been the only one which obtained good returns.

In 1889 the Forbes Alluvial Company found several tributary leads, all of which, however, were too wet for this company to work. In the same year the Crinoline and the Try Again (old Nil Desperandum) had been idle for a considerable time.

In 1891, Lewis and party prospected the South Lead and found payable wash-dirt.

* Ann. Rep't. Dept. Mines N. S. Wales for 1886, p. 62.

In 1893, again, Chester, Sully and party received aid from the Prospecting Vote to sink a shaft on the South Lead. They bottomed at 215 feet on wash which yielded half-an-ounce to the load.

Thence to the present time the South Lead appears to have been almost completely neglected. In 1896 Sinclair's Reef was found, and attention appears to have been directed from alluvial mining to reefing operations.

The influence of the Britannia Lode on the gold contents of the South Lead must not be overlooked. This has already been discussed in the general Chapter on the Leads.

A brief mention of the three leads ascertained to be dependent for their gold contents on the Britannia Lode may here be made. Others also may hereafter be found further to the South. The three known are Madman's, Grassatt's and the Britannia. They are short but rich tributaries of the South Lead, and they enter it from the right bank. In prospecting their gutters it was found that they headed in the Britannia Lode which is situated about half-a-mile south of the Forbes post-office. The main South Lead was very rich just below the points of intake of these tributaries.

Both the Madman and the Grassatt Leads appear to have been worked out but the Britannia has only been worked at its lower end, its connection with the Britannia lode not having been definitely proved. In the writer's opinion the upstream course of the lead will be found to be considerably further to the south than has been hitherto imagined. The reason assigned for not tracing the lead upstream is that the thickness of drift is too great as compared with that of the underlying clays. The clays being relatively thin the thick mass of overlying drift cannot be supported during mining operations.

ii. The Caledonian Group (Mathieson, Union, Victoria and Caledonian Leads).

Very little exact information exists concerning these leads.

The famous South Lead was found in 1861, and in the beginning of 1862 the Victoria was discovered. A couple of years later the head of the Union was located under Mr. J. Barton's house near the Forbes railway station. The discovery of the Caledonian followed shortly after that of the Union, and a little later again the King and Queen Leads were found to the north of the Doroobalgie railway-station. Prior to 1870 both the Thompson and Mathieson's Leads were worked, the former being the earlier discovery of the two. The Bald Hill Lead was not found until some time later (1874?) The date of the discovery of the Rise and Shine Lead is unknown.

Mathieson Lead.—Both the Mathieson and Thompson Leads head in small bosses of andesite which form the crest of the hill at the railway trucking yards at Forbes. Mathieson's Lead is shallow and of short length. It is tributary to the Caledonian Lead which picks up the Victoria at a point still lower down. Very little is known of the early working of the Mathieson beyond the fact that it was rich; that it possesed a rough and steep gutter, and that it is now practically worked out. A large nugget (8 lb.) was found here about the close of the year 1870 by the late Mr. R. Barton.

The Union Lead.—Very little is known of the early history of this lead. Along with some other gutters of Forbes, its richer portions were worked hurriedly before the close of 1864. In 1875, a party of eight found very good "surfacing" at the Union. In 1890, Lynch and party were working this lead. The depth of the gutter worked by them was about 80 feet.

The Victoria.—In the early days, magnificent gold values were obtained from this buried watercourse. The lead headed in the township of Forbes near Tattersall's Hotel, but a short distance downstream, the ground became deep. The early records of the working of this lead—as also those of the South and Caledonian Leads—are to be found in the reports of the Gold Commissioners, in the pages of the *Sydney Morning Herald* and of the *Forbes Times*. The history of the pioneer attempts is very similar to that of the South Lead. On the accompanying map, the Victoria is shown as tributary to the Caledonian Lead. Below the point of junction, the channel of the Caledonian was well defined, but the gold values appear to have been poor.

In 1877, a party of six took up an extended claim on the Victoria. This was one of several attempts about this time to work the deep wet leads of Forbes, after they had lain idle for about fifteen years. Like the others, this attempt was unsuccessful. The bottom box, sunk through the drift, bulged, and allowed a passage for the heavy water. Such mishaps were common when the bottom box had not been sunk sufficiently deep into the clay before "puddling back" was commenced. The Department of Mines loaned the party a diving-dress, but while operating with it, a flood came and washed the shaft timbers away. Work was then abandoned in 1879. This incident in the history of deep-lead mining at Forbes is mentioned to show the difficulties attendant on working the leads of this locality.

In 1889, the Phoenix Gold-mining Company worked the Victoria. Heavy water was encountered, but 200 oz. of gold was recovered. A quartz vein containing coarse gold was also struck in the bottom of the gutter.

The Caledonian.—This lead heads near the railway line and picks up the Victoria near the Rifle Butts. Below the Parkes Road, the ground is deep. From the head of the lead to its junction with the Victoria the ground was rich, but it is said to be practically worked out at present. Below the point of intake of its rich tributary, the Victoria, a definite channel was found, which however contained but very little payable gold.

iii. The Bald Hill Lead.

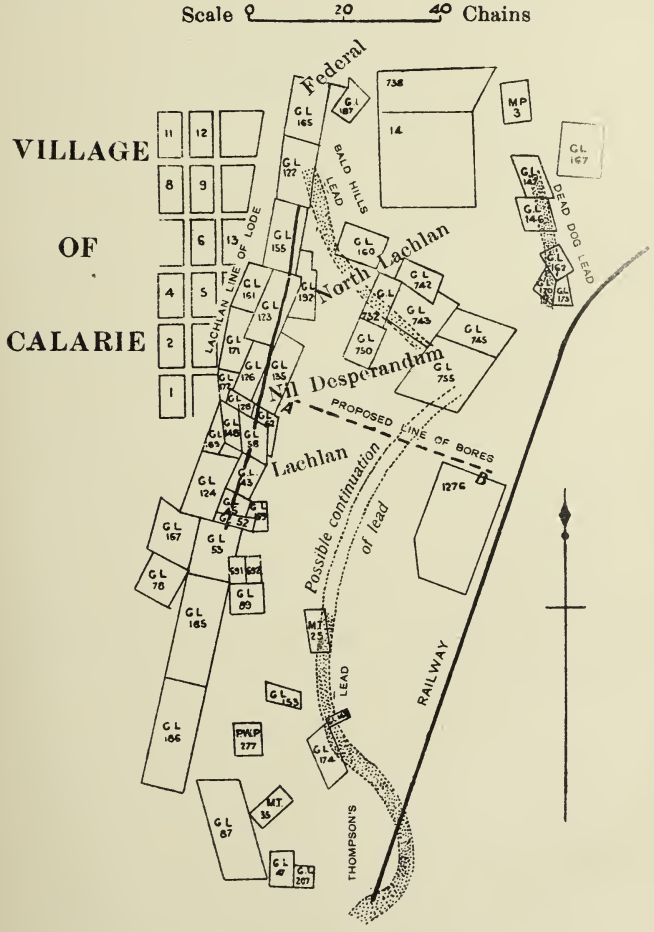
This lead appears to have derived its gold contents from the northern continuation of the lode known as the Lachlan; indeed, it is reported that the North Lachlan Lode itself was discovered by the process of tracing the Bald Hill Lead upstream. The lead was discovered about the year 1874; the gutter worked was 180 feet below the surface. During this first attempt it was worked without profit, and abandoned temporarily in 1875. In August, 1876, Mathieson and party took up portion of it as an extended claim. The sinking at first was through clay, then at a depth through masses of large boulders, the boulders being derived from the associated hills. The wash consisted of a decomposed breccia, clay and quartz gravel, while immediately over the wash came boulders of quartz and igneous rocks. The bottom was soft and swelling, and was composed of slate and allied rocks. The western bank of the channel was well-defined, but the eastern one had not been found in 1876—the wash exposed during that year being 30 inches in thickness and from 15 to 50 feet in width.

The first claims made about 1,800 gallons of water in 24 hours. The general return from the lead was from 5 to 12 dwt. per load. "The first occupants possessed neither whims nor adequate machinery for working deep

PLAN

Showing the relative positions of the LACHLAN LODE and the THOMPSON and BALD HILLS LEADS, CALARIE, near FORBES.

Proposed line of Bores to test ground indicated by broken line A B.



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and wet ground, and the water was constantly ruining their shafts and drives. . . . . This party have already raised and washed 100 loads; the result was 70 ounces. The value of the gold is £3 10s. 6d. per ounce." *

In 1879, a new shaft was put down on this lead, and the bottom of the gutter was reached at a depth of 200 feet from the surface. The shaft was slabbed and centred, with a well-hole 9 feet deep, because of the heavy water encountered. A drive was put in 120 feet south and 250 feet north. The width of the face exposed thus was about 60 feet, and the wash-dirt was from 18 inches to 2 feet thick; 700 loads of wash-dirt were puddled for a yield of 291 oz. of gold.

During 1883, more determined efforts were made to test this lead. Two leases were taken up by the British Standard Company. The shafts put down (several in number), bottomed at 180 feet; the wash exposed was 100 feet wide and from 2 to 3 feet in thickness, and it yielded from 10 to 15 dwt. per load. In all, 844 oz. of gold were obtained by the company for the year.

This success induced many parties to prospect the ground both north and south of the company's leases. Among these, Murphy and party had a trial washing of 8 loads, which yielded 5 oz. 12 dwt. of gold.

Upon the whole, however, this trial by the various parties of the Bald Hill Lead was not successful, and the claims were abandoned.

In 1884, another party worked the British Standard ground afresh. Their shaft was 190 feet deep, and the drives totalled 800 or 900 feet in length. The depth of the wash was 2 feet, and its width from 70 to 80 feet, of which 50 feet carried gold. During this year the company paid working expenses; 25 men were employed, and £1,000 worth of machinery was purchased.

Keeley and party about the same time carried out from 400 to 500 feet of driving on the lead east of the British Standard claim.

In 1885 the British Standard Company was wound up.

During the same year the late Mr. C. S. Wilkinson made the following report upon this lead.† "The Bald Hill Lead near Forbes trends in a south-easterly direction between hills of Silurian (sediments) with diorite. The sinking is from 186 feet to 240 feet deep, and the channel varies in width from 30 feet to 200 feet, the wash-dirt, which is said to yield from 3 dwt. to 4 oz. of gold per load, being 2 to 3 feet thick. The sinking is nearly dry, and not much water makes at the bottom. Some of the gold obtained is so extremely fine that it has been called "flour" or "paint" gold. The wash consists of sub-angular drift of quartz, quartzite, and large round boulders of diorite.

In 1889 the Bald Hills Extended Gold-mining Company worked during the whole of the year. An ordinary whim and a horse puddling machine were used only, and upwards of 2,000 loads of wash-dirt were put through for a yield of about 650 oz. gold. This company, later, erected a steam-winding plant, and sunk a main engine shaft to a depth of 180 feet.

During the year 1890 mining operations in the Forbes district were at a very low ebb. The Bald Hills Company carried out a great deal of prospecting, but failed to realise more than 137 oz. gold from 600 loads of dirt. The company ceased work; removed their machinery; and returned the auger-drill, which had been lent to them by the Department of Mines.

* Warden Dalton, Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 48.
† Ann. Rept. Dept. Mines N. S. Wales for 1885, p. 128.

Thompson's Lead.—This lead takes its origin in the patch of andesite near the trucking-yards at Forbes. At first the lead follows the railway line; then crosses it; then doubles back on itself across the railway again; thence it flows for a short distance towards the Lachlan Mine, but has not been worked beyond the point shown on the map. A gutter exists to the immediate north, but the gold values do not appear to have been sufficiently remunerative. The northerly continuation of this lead presents an interesting geographical problem. The present surface drainage of this area is to the east, while the course of the Thompson Lead here is to the north-west. The Lachlan Reef, however, which is barely covered by the alluvium, prevents it from getting through to the west, and it must have been deflected to the east at some point to the north of its present worked limit. Another lead, however, was worked to the north of this again, and which evidently entered the Thompson from the east, that is, its course is altogether against that of the present surface drainage. [This information has been supplied to me by Mr. Hasemer, of Forbes.]

Notwithstanding this, the former configuration of the country shows that the present Lachlan Reef, now buried under alluvium, must have stood as a ridge forming a valley wall of the Thompson Lead on the west, and the channel thus must have taken on an easterly course sooner or later. There thus remain two courses open to it. Either the Bald Hill Lead is the main channel, and the Thompson Lead is tributary to it, or the Thompson turns and has an independent course to the east before advancing so far north as the Bald Hill channel. It seems highly probable that the Lachlan Reef fed the Thompson Lead with gold in its passage northwards, and that the main drainage channel is the Bald Hills Lead, the Thompson being a tributary. In any case it would be advisable to put down a row of bores between the Bald Hill channel and the northern limit of the Thompson Lead.

The King Lead is supposed to have been worked in the early days for boom purposes. According to the statement of the late Mr. R. Barton, of Forbes, it was never remunerative.

The Queen's Lead.—The old workings known as the Queen's Lead lie about 8 miles north of Forbes. The ground had been occupied and abandoned in the early days of the field, because it was not continuously payable. About August, 1879, it was re-worked with such success that 300 men were soon on the ground. Many shafts were sunk, several of them bottoming at depths varying from 110 to 120 feet. The wash yielded from $3\frac{1}{2}$ to 8 dwt. a load. At the close of the year 1879 there were five parties on the lead, but the enforced cartage of the wash-dirt 4 miles to water, led to the temporary abandonment of the claims.

Towards the close of 1881 a shaft was sunk on the old No. 6 claim. Bottom was struck at 128 feet on hard slate; thence long drives were put in, and the width of the gutter was ascertained to be 25 feet, the wash being from 6 inches to 2 feet in thickness. While putting in these drives a large quartz reef, 3 or 4 feet thick, was discovered, but no gold was seen in it.

(*b*) Parkes Leads.

i. The No Mistake Lead and its Branches.

In 1871 alluvial gold was found 5 miles north-west of Parkes. This was at the head of the No Mistake, the first lead worked in the Parkes district. The lead was 2 miles in length, with a depth of as much as 120 feet. The

wash was about 12 inches in thickness. It was not the first discovery of gold, however, in the Parkes district, for in 1862 James Pugh had found the Pioneer vein immediately to the north of the present township.

Reid's Gully.—This is a narrow and crooked tributary of the No Mistake, discovered about the close of 1873. It has been traced for a distance of about 2 miles, and its upper course is separated from the No Mistake by a high ridge of schistose slate. After a course of about a mile and a half, it effects a junction with the No Mistake. At its head it is about 40 feet deep, gradually deepening to 97 feet at its junction with the No Mistake. Below the junction of the two leads a prospecting campaign was carried on during 1874. At a depth of 115 feet good prospects were obtained from a decomposed andesite. This lower lead, however, does not appear to have been as payable as its tributaries were. Both the No Mistake and the Reid's Gully leads were practically worked out before the close of the year 1880.

ii. The Bushman Group and its Tributaries.

The Bushman.—In July, 1871, Brogden and party discovered the rich alluvial lead known as the Bushman. This was on the present site of the Parkes township. Sir Henry Parkes visited the spot, and soon afterwards the name of the old village of Bushman was changed to Parkes. Brogden afterwards claimed a Government reward for the discovery of a payable goldfield, but it was proved that *James Pugh had discovered the payable Pioneer Reef nine years previously.

The Bushman Lead heads in a belt of crushed andesite, and at this spot is known as the Shallow Rush. It is from 15 to 20 ft. in depth. After crossing the Condobolin road it turns at right angles and parallels the same road until the town of Parkes is reached. The lead passes right under the centre of the town at a depth of from 75 to 90 ft. below the surface, and picks up the Little Bushman there. The depth of this tributary was as much as from 60 to 80 ft., and its wash-dirt was worth about 15 dwt. to the load. The lower course of the Bushman proper is known as the Great Northern, which, near the railway station, picks up the 'Possum Gully Lead. Another tributary is the Sardine Lead which effects a junction with the main channel near the crossing of the Billabong Creek by the Molong railway-line. These features are all shown on the general map accompanying the report. The Great Northern Lead proved a puzzle to the miners. It was followed to the Billabong Creek, and thence upstream for some distance. It then returned to the western side after a northerly course and entered a lagoon or basin, occupying a position about 92 ft. below the present land surface, and 70 ft. below the present creek level. The basin is of considerable extent, and it underlies a large portion of the western bank of the creek and extends thence across to the east bank. It contains wash-dirt from 2 to 7 feet in thickness. Many attempts have been made to work this basin, and to ascertain the continuation of the lead downstream, but such continuation has never been found. It is evident from the configuration of the country that it cannot continue its course up the Billabong for a great distance, but that it must turn downstream at a short distance only above the lagoon just mentioned. There are two courses open to it: Either it turns on itself shortly above the lagoon site and flows southward under the alluvium between the Billabong Creek and the Bartley Creek railway platform, or it

* Warden Sharpe's Report (Prospecting Board, 87/15730).

moved towards one of the gaps in the hills near the Molong road. The probable course of the deep lead is discussed, however, in the general Chapter devoted to the Leads.

iii. The Welcome Group.

This group consists of the Welcome, Tearaway, Frenchman's, Paddy's Flat, Little Welcome, Melbourne, and Fulton Leads.

The positions of these are indicated upon the map. The general appearance of the group in plan is similar to that of a branching tree. The main lead was discovered in 1872 ; then came the finding of the Tearaway in 1873, with that of the New Welcome, finally, in December, 1875.

The leads of the Welcome are shallow. At one time the Tearaway was supposed to be the main lead, and the "Old Welcome" Reef, situated on the Tearaway, derived its name from this circumstance. The main channel had a greatest depth of 140 feet., and at the point where it passed underneath the Billabong Creek it turned upstream. A great amount of prospecting was carried out along this portion of the lead, but the amount of wash-dirt was so large and the gold values so poor that the work was abandoned and has not since been resumed.

The Tearaway.—In 1873 this was called the Terrace. The channel is about 1 mile in length, and it was at one time supposed to be the head of the main lead, and for that reason the "Old Welcome" Reef lying alongside of it receives its name. The Terrace has produced large nuggets, some of which, found in 1874, weighed 7 oz., 25 oz., 35 oz., 37 oz., and 134 oz. respectively. In 1876 nuggets as large as 30 oz. were found. The depth of the gutter was shallow, rarely exceeding 20 feet. The lead is now practically worked out.

The Frenchman's Lead.—This tributary is about a mile in length and is situated on a slope separating Paddy's Flat and the Victoria Lead. It is shallow, rarely exceeding 12 to 14 feet in depth. The average value of the lead was from 3 to 4 dwt. of gold per ton of wash-dirt.

Paddy's Flat and the Yarran.—On the flat extending westward from the Tearaway is a short channel known as Paddy's Flat. The sinking here was about 80 feet and the channel itself is apparently a connection between the Yarran, the Frenchman, and the Main Welcome Leads. The Yarran is a short rich western feeder to Paddy's Flat.

The Fulton Lead.—This "run" is tributary to the Welcome, and enters it near the point where the latter passes underneath the Billabong Creek. Its depth is from 45 to 100 feet and the thickness of the wash-dirt is from 12 to 20 inches. It was not payable except in a very few places ; six months after its discovery it was abandoned.

The Welcome itself has not been worked much below the point of intake of the Fulton, partly because of the very wet ground encountered, and partly because of the width of the gutter and the scattered nature of the gold contents.

The Fulton appears to be a continuation of the Nibbler's Lead.

The Melbourne Lead is a short tributary of the Welcome, entering it on the right bank and at a point situated a little upstream of the intaking o

the Fulton. It has a peculiar course, commencing in a flat near the Fulton, then turning at right angles and flowing parallel to the course of the Fulton. The Melbourne is practically worked out.

In 1891 Mr. J. E. Carne reported on an application for aid from the Prospecting Vote to continue the search for "the south-eastern extension of the Welcome and other leads which terminate close to the northern bank of the creek." (P.B. 91-3381). The site chosen by Drew and party as the scene of prospecting operations was C.P. 74–4396 of 320 acres on Billabong Creek, Ph. Mugincoble, and taken up by A. George. Mr. Carne stated that the Fulton Lead, which posssessed a course almost east and west, was also supposed to cross the selection. "About 150 yards north-westerly from the present prospecting shaft is an old shaft which was put down some years ago, and a little gold was found at the bottom—127 feet. It is reported that this shaft was lost owing to a flood in the creek. At the time of my visit the present prospecting shaft was down 50 feet, the latter 30 feet in coarse drift, it was expected that the bottom would be reached at about 130 feet."—(J.E.C.) Fourteen shafts were sunk during the prospecting campaign, the depths being 52 feet, 147 feet, 149 feet, and 154 feet; 100 feet of driving was also carried out from the bottom of the 154 feet shaft. The attempt apparently was not successful.

iv. The M'Guiggan Group.

This embraces the M'Guiggan North and South.

The M'Guiggan has been perhaps the most important of the Billabong (Parkes) leads, partly because of its intrinsic value and partly because of the successful impetus it gave to prospecting operations in the Parkes district. In the early seventies many of the miners of the Parkes district went to the Palmer Field in North Queensland because of the local mining depression. On the 8th March, 1874, M'Guiggan and party, who meanwhile had been prospecting that belt of auriferious country which contains the Blue, Scrub, London, Victoria, New Haven, and Band of Hope lodes, obtained good gold in their shaft of 48 feet deep. Magnificent returns soon followed, and men flocked back from the Palmer, from Grenfell, and from other places, and by June of the same year the district had a population of nearly 10,000 people. M'Guiggan and party obtained their prospects at a depth of 48 feet. Thence for a distance southward for about two miles the lead was followed deepening as it went. The map shows its course. The deepest ground worked was about 160 feet, and the yields varied from about 3 dwt. to 3 oz. of gold per load. North of the Goobang Creek it was called M'Guiggan's North, but after passing underneath the creek it was called M'Guiggan's South.

In 1874 the best of the gold had been won from the M'Guiggan Lead, and at the close of 1875 only a few claims in the M'Guiggan's South were being worked. Almost without exception the leads of Parkes and Forbes had ceased to be payable on crossing the main Lachlan and Billabong streams, but the M'Guiggan South was an exception. For a considerable distance south of the Billabong Creek it was decidedly payable. Beyond a certain point, however, indicated on the map, the gutter became less defined; a "gilgai" appearance was developed in the channel drift; the gold became scattered; and after an expensive prospective campaign the miners gave up search for the continuation of the lead to the south.

The following plan and section of this lead, taken from Mr. Dalton's report for 1875, illustrates the general physiographic features of the lead.

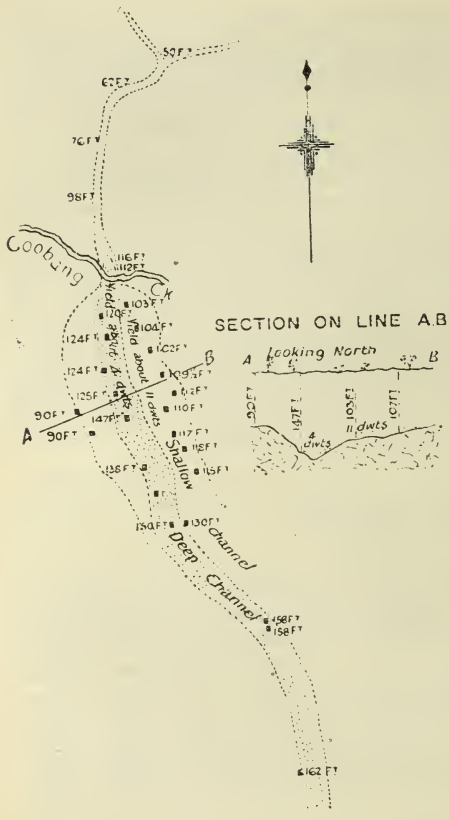

FIG. 6—Plan and section of M'Guiggan's Lead, taken from Warden Dalton's Report in "Mines and Mineral Statistics," 1875.

Three dishes off the bottom yielded 1 dwt. of gold. The ground was quickly taken up under the frontage system, but as it was not of the required depth, it was ultimately held in block claims for one mile north and south of the prospector's claim. M'Guiggan's Lead proper, as it deepened from 48 to 115 feet was very productive. The centre of the lead was the richest portion. The bottom was pipeclay, with occasional patchesof compact clay, slate, sandstone, and decomposed andesite.

M'Guiggan's South is a continuation of M'Guiggan's North. Before finding the M'Guiggan South, however, the Tichborne Lead was found. It has been proved for about one and a half miles south of the Billabong or Goobang Creek, and it was occupied along a north and south line under the frontage system in June, 1875. The miners sought in the deepest ground for the lead, and one after the other they exhausted their means in vain attempts to locate the lead. Wash in abundance was always present, and gold also, but not payable. The holders of a claim distant about a mile from the creek bottomed at 157 feet upon good wash. Still the main lead had not been located. Finally a shaft, which had been sunk at random 100 yards eastward, bottomed at about 140 feet and struck the long-sought lead. The depths of the original line of shafts were from 120 feet to 157 feet, deepening with distance from the Billabong Creek. The course of the M'Guiggan's South was parallel to this line, but was not so deep by as much as 15 or 20 feet.

The following extracts show the importance of M'Guiggan's lead:—"From M'Guiggan's Lead, four men obtained, as the produce of two washings, 650 oz., and have still two years' work in the same claim; six men, as the result of two washings, obtained 656 oz.; four men's claim worked out, 500 oz.; four men's claim, not worked out, 500 oz.; six men, the proceeds of one washing, 400 oz.; and from two men still working in the same claim, 300 oz. . . From claim-holders on M'Guiggan's one establishment alone informs me that they have purchased about 900 oz. of gold during the last six months, the whole of which is alluvial."*

* Warden Dalton, Mines and Mineral Statistics N. S. Wales, 1875 pp. 36-37.

The prospecting claims mentioned below, produced the following results :—

1. M'Guiggan's	2,140 oz. 4 dwt.,	value	£8,025	18 0
2. M'Gee's	1,209 oz. 11 dwt. 19 gr.	,,	£4,535	17 9
3. Cook	1,950 oz.	,,	£6,312	10 0

Besides these claims, others have given out great quantities of wash too, and permitted shareholders to clear from £500 to £1,000 each.*

v. The London Group.

This group consists of the London, the Little Wonder, the Sydney Clinker, and the All Nations.

The London heads from a zone of old and crushed rocks. It was opened in April, 1874, with the finding of payable gold prospects at 42 feet in No. 12. The lead itself was traced for a distance of nearly two miles.

The central claims were the only ones, however, which were payable; that is, the payable portion of the lead was confined to the limits of the claims No. 12 to 19. No 19 especially, gave splendid results. A peculiar topographic feature was revealed by the workings downstream of No. 19. At its head, the lead was 27 feet deep, and as far down as No. 18 even, the lead had not exceeded a depth of 75 feet.

At No. 20 it was 83 feet, but below No. 19 the ground showed a steep decline from 85 feet to 140 feet. No. 23 was from 175 feet to 200 feet deep, between limestone walls. Along the central ground the bottom had been shale and sandstone in benches, with bands and blocks of brown hæmatite. Here the ground had been payable.

Below No. 20 wash was plentiful, but almost barren of gold, although the metal was found scattered during sinking operations, although never in payable quantities. Many reasons were advanced to explain the poverty of the deeper ground. Among others, Mr. Wilkinson, the late Government Geologist of New South Wales, may be quoted in this connection :—

"Such not uncommon occurrences may have originated in various ways; for instance, at the particular time of the deposition of the gold-bearing drift, the old stream may have been wearing away, and distributing as drift, some auriferous bed-rock or quartz reef, which had no great depth; consequently, when the river had eroded its channel to a lower level, the underlying rock it then acted upon may have been non-auriferous, and therefore, the drift derived therefrom, would be so, also. Again, in Silurian country, there have been frequently noticed belts of non-productive rock, running parallel and alternating with rich tracts. These, then, under certain circumstances, would also afford an explanation of the above-mentioned facts."†

As with the M'Guiggan Lead, so with the London, a deeper channel runs parallel to the lead, but its wash does not appear to have been payable. In some of the claims along the London, a consolidated drift or cement was found, and this proved to be as rich as the ordinary wash-dirt. Boulders were frequent in the wash between the claims from No. 14 to 19, and these consisted entirely of nodules and blocks of a compact rich iron ore.

Another peculiar physiographic feature is the existence of a channel down stream of No. 21 claim. In No. 20, bottom was found at 83 feet, but another channel passes underneath this again, at a depth of 170 feet. In the

* Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 85..
† C. S. Wilkinson, Mines and Mineral Statistics N. S. Wales, 1875, p. 121.

latter, a poor river wash about 8 feet thick, was found. The existence of this main stream chanuel had long been known, as it was discovered on the opening of the London Lead. It had also been found to cross the Ben Nevis Lead half a mile further to the west.

The tributaries of the London are the Little Wonder, the Sydney Clinker, and the All Nations. These are all short in length. The Little Wonder effected a junction with the London at No. 15; its depth was from 70 to 90 feet, its channel crooked and narrow, and it was very rich in places. The Sydney Clinker and the All Nations, however, were never remunerative.

Although the London Lead has been worked intermittently almost up to the present, nevertheless it was practically worked out in 1880.

vi. The Tichborne Group (Tichborne, Fairy, and Wapping Butcher).

The Tichborne.—This lead was discovered early in July, 1874. Geographically and chronologically it falls into the group of leads, of which the Ben Nevis, London, M'Guiggan's, and Wapping Butcher are members. Murray and party were the first to hoist their flag over this lead and to report payable gold. This was in the vicinity of Tom's Knoll, or what is now known as Miller's Hill,

The Tichborne lead, one mile east and one mile west of the prospecting area, was then declared. The claims or areas on the eastern line were afterwards found not to be of the expected depth, the frontage system on that portion of the lead was then abolished, and the system of block claims instituted. The prospectors' claim exceeded 100 feet in depth. The block claims to the east varied from 72 feet at the head to 90 feet by the prospectors, and the wash varied in thickness from 2 feet to 17 feet. The frontage areas to the west deepened from 106 feet in No. 1 to 130 feet at No. 11. Beyond this point towards M'Guiggan's South the depth was still greater.

The channel of the Tichborne is somewhat deeper than that of the Wapping Butcher, which appears to be tributary to the former. The wash also is finer in the Tichborne, and contains more clay and sand, as well as a smaller number of boulders. The course of the lead is crooked, and the channel varies in width, the under portion being 100 feet. The wash varied from 3 dwt. to 1½ oz.

The original prospectors shared the fate common to pioneers. They obtained their prospect of 2 dwt., and no more; sank and drove 1,200 feet, and after eight months labour, and having defended two actions initiated by jumpers, abandoned the ground. Below the prospectors down to No. 9 frontage the claim yielded little more than wages.* Many of the leads were rich, those to the east being almost uniformly so.

The Frenchman's Block (East) had 17 feet thickness of wash, and from 5,000 loads four shareholders realised £5,000.

From No. 6 (East) Mooney and party realised £900 a man. 100 oz., 120 oz., 150 oz., and 250 oz. of gold were obtained from trial washings in four eastern claims. From No. 6 (East) McCann and party won 1,700 oz. gold during 1875.

It has been mentioned already that the claims taken up to the south-west of the prospectors' were not nearly so rich as those to the east of this claim.

* Ann. Rept. Dept. Mines N. S. Wales for 1875, p. 34.

Of 19 frontage holdings only six were payable, and no well-defined lead was discovered. Indeed, the lead was believed to have been worked out by the end of 1875. Another attempt, however, was made in the latter half of 1879 to prove the supposed continuation of the Tichborne with the South M'Guiggan Lead. At that date McClelland and party took up a prospecting area near No. 11, M'Guiggan's South, and struck an auriferous wash 12 inches to 18 inches thick and 25 feet wide at a depth of 123 feet.

A clearly-defined channel was found with a south-westerly course. Fine sand and boulders, similar to those occurring at the head of the Tichborne, was passed through. The wash also was of the same description. The prospectors drove north, south, east, and west. Eleven loads were washed, and yielded returns at the rate of 6 dwt. 12 gr. per load. This claim turned out to be quite payable, and four other parties rapidly took up claims over the lead. Some of these produced payable gold. This claim was within a short distance of No. 10 on the Tichborne, and it is thought that the two leads, the Tichborne and M'Guiggan's South, are connected.

Fairy Lead.—This heads in Miller's Hill, and has a northerly course before it joins the Tichborne Lead. Two series of auriferous gravels were found, the one a shallower and a heavier deposit than the lower one. The lower one, about 50 feet in depth, was not as payable as the upper one. The shallower deposit was overlain by about 15 feet of very fine red sand. The whole lead was short, but payable, but it is supposed to have been worked out. One claim produced £2,000 worth of gold, and three other claims each produced gold to the value of from £1,200 to £1,800.

The Wapping Butcher.—This lead has a northerly course, and is tributary to the Tichborne. It was found in the latter part of 1874, immediately after the discoveries of the Tichborne and M'Guiggan's South, and just prior to the finding of the Fairy and Fulton Leads. According to Mr. Warden Dalton,* the Wapping Butcher was a continuation of the Fairy Lead, "both following the summit of a ridge of palæozoic rocks, that, at a depth below the surface varying from 45 feet to 72 feet, extend to the northward." From a study of the map, however, it seems probable that both the Wapping Butcher and the Fairy Leads are independent tributaries of the Tichborne Lead, the one entering from the north and the other from the south. The ridge of underlying rocks, along the top of which the Wapping Butcher and the Fairy Leads flowed, appear to have been notched in its central portion. In this deepest position the alluvium was 72 feet deep, while to the north and south the ground gradually became more shallow, until it was 54 feet deep on one side and 45 feet on the other. One hundred yards to the east of the Wapping Butcher the alluvium of the plain becomes much deeper, and consists of clays and gravel. It would thus appear that the channels of the leads we are considering are of later origin than the channels existing just at the commencement of the subsidence, which resulted, finally, in the formation of the broad alluvial plain of the Billabong Creek.

At the base of the Wapping Butcher channel large quartz boulders were encountered, some too large to move without the aid of blasting. With these boulders were associated pebbles, red, brown, and white clays, and blocks of conglomerate.

Locally, these fragments of conglomerate were known as clinkers, and, with the exception of the cement, they were similar in character to the loose wash. It is interesting to note that solid nuggets of water-worn gold have

* Ann. Rept. Dept. Mines N. S. Wales for 1875, p. 32.

been frequently obtained from them. "The clinkers at the . . . Wapping Butcher . . . are crystallized, some exquisitely shaped. . . . The largest piece of a clinker at the Wapping Butcher was 9 feet high. At the Wapping Butcher and Tichborne Leads these bodies contain gold *in situ*. From one weighing 3 lb., 3 oz. of gold were obtained; from another, 1½ oz., and so on. They are, inside, pure white, with rarely very slight external colouring. These crystallized clinkers prove most obdurate, defying the pick and the gad."*

The lead varied from 45 feet to 70 feet in depth; it was about a mile in length; the wash being from 1 foot to 16 feet in thickness; and the channel was as much as 200 feet wide in places.

The northern end of the Wapping Butcher was never satisfactorily determined. It has been thought that the Growler's Lead (see map) is its continuation. Another idea was that the Fulton either represented a tributary to the Wapping Butcher or was its actual continuation. In any case, a great amount of prospecting has been done to the north of the supposed junction of the Growler's with the Wapping Butcher.

A section of the alluvium, as exposed in a shaft on a claim worked by W. Jones and party, gives a fair idea of the nature of the sinking on the lead. The claim was 220 feet square, and situated on alluvium in the midst of a dense pine scrub, and gave no indication of a buried watercourse below.

The beds passed through were:†

Chocolate soil	4 feet
Yellow striated clay, mixed with quartz gravel	10 ,,
Quartz gravel	4 ,,
Partially decomposed conglomerate of quartz gravel, pebbles, and boulders, mixed with fragments of ironstone, igneous and transmuted rock and various slates and shales	20 ,,
Coarse red and brown sand and drift	12 ,,
Auriferous drift apparently derived from the base of the conglomerate	4 ,,
Total	54 feet

The greater part of the conglomerate was disintegrated, and the majority of the pebbles, with the exception of the quartz and silicified fragments of schist, were altered to clays of various colours, the clay pebbles being in many cases reconsolidated by an infiltration of lime and iron. Where the lime and iron had not been removed large blocks of the conglomerate remained in their original state. These masses were known locally as clinkers. The base of the conglomerate-like drift often forms the auriferous wash in this part of the field.

The sinking operations in the claim of Murphy and party were through:

Brown soil	5 feet
Sand and drift	5 ,,
Friable red clay	30 ,,
Coarse gravels	2 ,,
Chocolate coloured friable clay	10 ,,
Conglomerate...	3 ,,
Total	55 feet

* H. Margules, Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 83.
† Ann. Rept. Dept. Mines N. S. Wales for 1875, p. 33.

The Wapping Butcher Lead was short but very rich. A trial washing of 46 loads from one of the claims yieled 109 oz. of gold. In 1875 Carroll and party took out 1,200 loads for 1,600 oz. of gold from a small claim 220 feet square. Bowes and party, from a similar area, obtained £4,000 worth of gold. From the claim of Jones and party, just described, a washing of 1,005 loads yielded 2,707 oz. of gold. Only one third of the claim had then been worked. From an adjoining claim a nugget weighing 26 oz. was obtained. In the same locality, Kenna and party obtained 1½ oz. per load, Francis and party 1 oz. per load, Murphy and party, 3 oz per load, also cement with fine results, and nuggets up to 20 oz., M'Fadden and party, 2 oz. per load, and Williams and party, 3 oz. per load. Farrell and party 2,200 loads for a yield of 1,543 oz,, many nuggets being 5 and 6 oz. each, the largest being 16½ oz. Messrs. Barlow and party, 600 loads for 450 oz. The "cement" was also rich in places, sometimes yielding results when crushed as high as 2½ oz. per ton.

vii. Ben Nevis Lead.

This lead has never been very remunerative although it has been well prospected. It heads in a mass of schistose slates, tuffs, and andesite flows. It was opened up in March, 1874, and was worked for a distance of from one and a half to two miles, but it was practically deserted in 1875.

The lead was narrow at the head but it widened out downstream. The bottom descended suddenly * from a depth of 25 feet to one of 120 feet in less than half-a-mile ; then again it ascended as suddenly to a depth of less than 100 feet. A belt of amygdaloidal basalt, known to the mines as "Tertiary bottom," is said to have crossed the lead from north to south.†

An interesting feature in connection with this lead is the thick accumulation of clays and the depths of the channel at isolated spots. Thus, on the ground known as No 2 North, Messrs. Frampton and party sank a shaft to a depth of 204 feet of which 117 feet was through clays. The clays were yellowish and impregnated with minute crystals. Occasional layers of gravels, sandstone boulders, sand, and belts of auriferous river wash were passed in sinking the shaft, the gold being fine and not in payable quantities. At a depth of 204 feet a layer of fine white sand was met and subjacent to this lay an indurated limestone, which gave off an unbearable odour. Auriferous drift was also found at this depth. Frampton believed that 20 feet more of sinking would have proved the ground, but the patience of the party had been exhausted and the claim was abandoned.

viii. The Scrubby Plains.

This is a portion of the alluvial plain of the Billabong Creek, near the village of Tichborne.

On the plain, which is practically devoid of watercourses, the surface gives little or no indication of the buried stream channels, hence the difficulties which arise when prospecting this ground.

Examples of such buried channels are the Welcome, the M'Guiggan, the London, and the Tichborne, which, as they passed under the alluvial cap proper, were traced only with difficulty. As a result of these rich finds,

* Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 83.
† *Ibid*, p. 83.

indiscriminate prospecting ensued over the whole area in the hope of locating defined channels. About a mile and a half from the lowest points yet worked, downstream along the leads just enumerated, four small block claims were taken up on a channel, which evidently formed part of a lead. From a depth of 54 feet, these claims produced about £50,000 worth of gold.* It was found impossible to connect this channel with any known lead, although many experienced miners believe such connection does exist.

In March, 1876, Dunlop and others reported payable gold at 135 feet deep, about three miles south-east of the Tichborne Lead. The prospectors' claim being unpayable, however, they abandoned the place.

For a period of two months, in 1876, Messrs. Duke and party tested that part of Scrubby Plains, which lies about one and a half miles south of the M'Guiggan Lead, one and three quarter miles from the southern bank of Billabong Creek and not far distant from a reef prospected by Cotton and party. Shafts were put down in a line, with depths varying from 10 feet to 40 feet, from 60 feet to 82 feet, and from 83 to 95 feet. From the bottom of one of these they drove 140 feet. Plenty of "river wash" was obtained and fine gold was found, but the ground did not prove to be payable. Hundreds of miners were shepherding alongside, but none attempted to sink, and finally Duke's party abandoned the ground. "Had the ground there been held under the frontage system, the width allowed by it constituting some security to miners for work expended, many shafts below and above the prospectors' would have gone down and thus the locality would have received a proper test."†

It has been thought by the mining community that this deep ground may not have been as valuable as the more shallow gutters, which doubtless exist in the neighbourhood of the deeper ones. In this connection it may be noted that about eight leads, each from 1 to 3 miles in length, had been traced on the northern bank of the Billabong Creek and had been worked to the edge of that stream, where, at 70 feet below the base of the present channel, auriferous wash had been found. To the south, all search for them proved more or less unavailing, with the notable exceptions of the Tichborne, the Wapping Butcher, and the M'Guiggan South.

In 1885, Mr. Wilkinson, the late Government Geologist, visited the Scrubby Plains in connection with a prospecting campaign, and the following note was made by him on that occasion:—

"Some of the prospecting shafts on Scrubby Plains reached a depth of 161 feet, passing through yellow ferruginous and white sandy clays, pipe-clay, and and a little quartz-pebble drift, partly cemented with ironstone and containing colours of gold; the bed-rock is Silurian slates with quartz veins."‡

Later again, in June, 1886, a rather extensive rush took place to the Scrubby Plains, when 450 miners were on the ground at one time. Prospecting was carried on with Government aid and the prospectors reported that payable gold had been discovered by them. The depth of the shaft was 56 feet, the wash being from 3 to 9 inches in thickness. The attempt, however, proved to be unsuccessful.

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* Ann. Rept. Dept. Mines N. S. Wales for 1878, p. 71.
† Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 87.
‡ Ann. Rept. Dept. Mines N. S. Wales for 1885, p. 127.

ix. Minor Leads.

The Victoria.—The lead of this name heads in the same mass of crushed slates and allied rocks as the London and the Ben Nevis. The country associated with the lead contains numerous gold-bearing lodes.

The lead was short and unimportant; its depth was 14 feet, and the thickness of the wash-dirt was from 6 to 18 inches.

Magpie Lead.—The finding of the Magpie Lead was the result of an attempt to prove the alluvial ground to the south-east and the south-west of the leads near Tichborne. Geographically, the country tested is a southern extension of the Scrubby Plains. The prospectors obtained good results; a rush set in, and 200 men came on to the ground immediately. This was during the commencement of 1879. For two months the men prospected the ground, but without success. The depth of the ground was from 90 feet to 130 feet, the thickness of the wash from 6 to 12 inches, the bottom a series of gilgais, from the sides of which the prospects were obtained. No well-defined channel was ever found. In spite of this failure the majority of the miners were of the opinion that a payable "run" of gold existed in the locality.

"In sinking upon the plains to the south of the Tichborne, in various parts, the result has been always the same as on the Magpie Rush, gold, but not in payable quantities."*

Nibbler's Lead.—This short gutter was discovered early in 1874. It is either tributary to, or is the head of the Fulton itself. The depth was from 25 to 30 feet, and the wash was about 12 inches thick. The prospecting claim yielded 1 oz. of gold per load. A little fossicking is still carried on at various times.

The Growlers' Lead is short, and was discovered in 1874; its channel is narrow and difficult to follow. The depth is only 14 feet. Two of the claims yielded as much as 18 dwt. of gold a load, but the remainder yielded wages only.

The Well Tried Lead.—This heads in the same belt of country as the M'Guiggan. At its head it consists of surfacing. It is a long, shallow gutter, which has been almost completely worked out.

The Secrets Lead is situated about six miles to the north-west of Parkes, near the Bulgaldramine-road. The date of its discovery was 1901. The depth of the sinking was about 90 feet, and the yield was about 4 dwt. of gold to the load. Many claims were taken up, but the only payable one was the prospectors'.

B.—The Lodes.

(*a*) Forbes.

i. The Lachlan Line of Lode.

The notes on the discovery and prospecting of the Lachlan Lode (and its northern extension comprising the Nil Desperandum, the North Lachlan, and the Federal) have been supplied by Mr. J. S. Sanderson and Mr. J. O'Shanassey, formerly assayer and underground manager respectively of the Lachlan Mine. The notes on the progressive development of the lodes subsequent to 1897 have been obtained from the Annual Reports of the Department of Mines for the years 1897 to 1909.

* Warden Dalton, Ann. Rept. Dept. Mines N. S. Wales for 1879, p. 90.

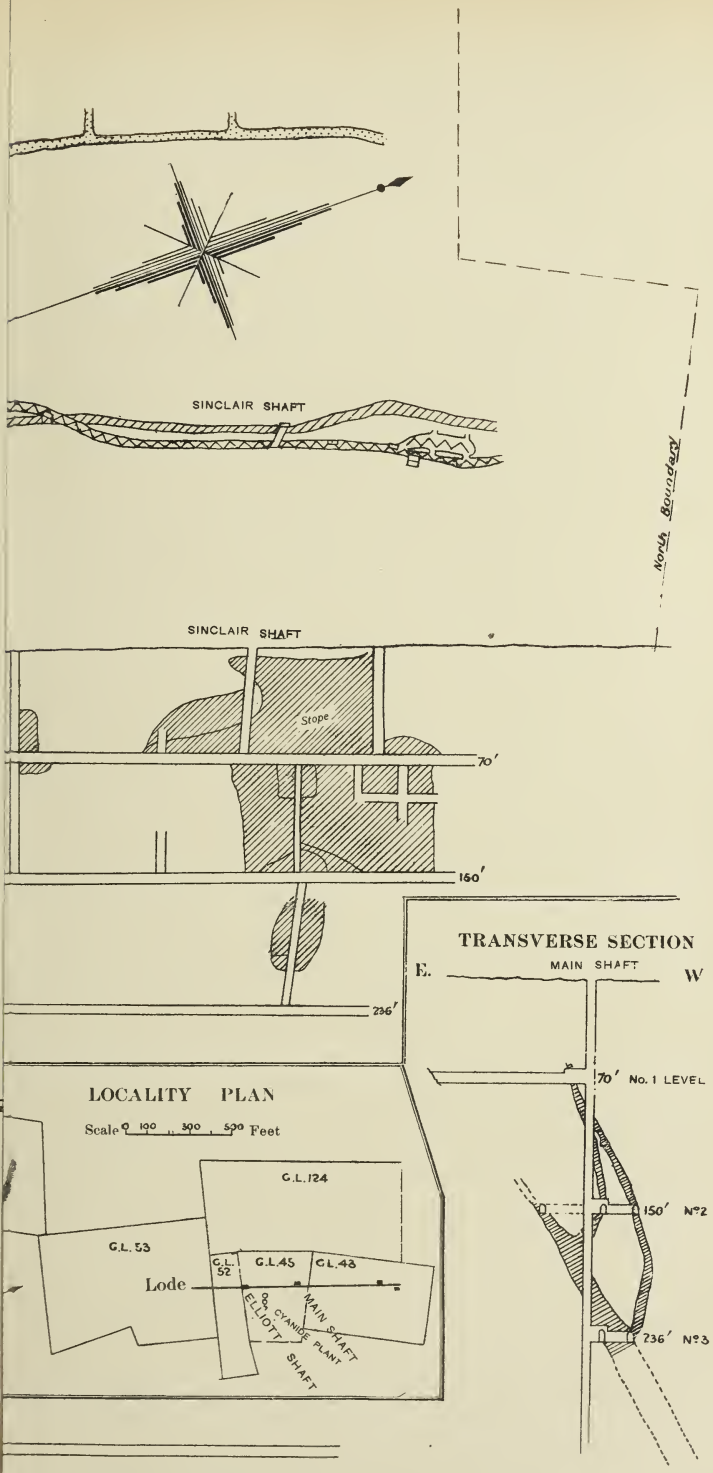
The "Lachlan" Lode was formerly known as "Sinclair's Reef." It outcrops only as a small ironstone mass, the remainder of the long line of lode being completely buried beneath a wide alluvial terrace. Its existence was inferred from the occurrence of—

(1) "Leads" which had been traced upstream towards the position occupied by the lode.

(2) An ironstone outcrop about 3 chains south of the present main shaft on the reef.

With this evidence Sinclair and party decided to sink on the ironstone. During the prospecting operations the ironstone was found to be associated with andesites, both porphyritic and felsitic in appearance. These andesites in turn were observed to intrude sedimentary rocks. The latter had been much altered by mountain-making forces. Claystones had been changed to silky slates; individual fragments of breccias had been drawn out into augen-structures, and even at times into thin parallel plates of graphitic slate. The lode itself was found to have commenced as a quartz deposit formed in open fissures between the andesite dyke and the altered sediments. Where prospected the lode was about 4 feet wide, but it was soon ascertained that large lenses of ore were associated with the fissure. Thus the "Cellar," which was opened up near the 150 feet level, represented one of these lenses, and was from 20 feet to 30 feet wide, 100 feet long, and 50 feet deep. Other large lenses occurred both in the Lachlan Lode itself and in its northern extension known as the North Lachlan. In all these instances the enlargement of the ore bodies appears to have been due to replacement agencies. The underground workings of the lode were not accessible to the writer in 1909, because all mining operations had been suspended; nevertheless, from the samples of ore and gangue lying about on the surface the conclusion was inevitable that a great percentage of the ore masses had been due to the replacement of country by the action of heated waters. Networks of tiny fissures were first developed, which were filled with silica and various sulphides. From these tiny veins a gradual alteration of the intermediate areas took place, until complete replacement had taken place at certain favourable situations, while at others the silification progressed only to such a degree that the country between the veinlets appears now as a mass of breccia. All gradations from networks of veins in, to complete replacement of, the the country may be seen. This throws an important light on the origin of the "breccias" so frequently found in mines where the individual fragments of the "breccias" are not in contact with each other. It would be interesting to examine them in the light of the possibility that they represent a minor phase of replacement by quartz, calcite, or other minerals acting from networks of tiny fissures. The Eleanora Reef, of Hillgrove, appears to be a case in point. The associates of the gold, besides quartz, are calcite, iron, and arsenical pyrites. In the upper portions of the lode the pyritic content has been frequently leached out, leaving cavernous or honeycombed quartz, which merges gradually into the pyritic zone at depths of from 150 feet to 230 feet. Water level, according to Mr. O'Shanassy, occurs at about 75 feet. The hanging wall is of slate, the footwall of andesite; the footwall is well defined.

The original prospectors of Sinclair's Reef found stone varying in value at the surface from 5 to 16 dwt. Two whip shafts were then put down, and shortly afterwards the mine was floated into a company, with 75,000 £1 shares.

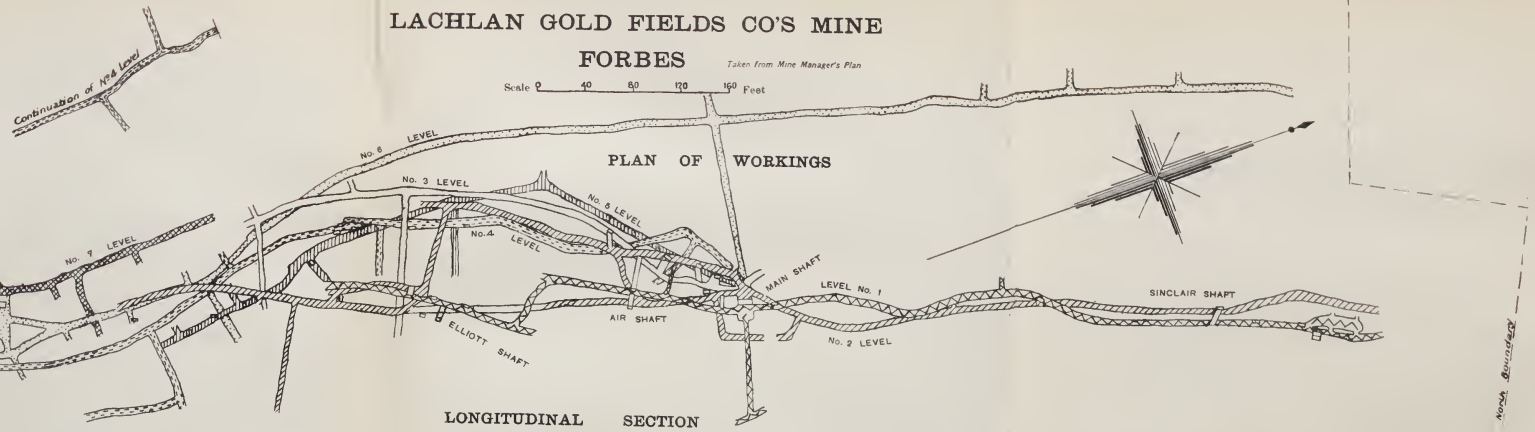

SINCLAIR SHAFT
North Boundary
SINCLAIR SHAFT
Stope
70'
150'
236'
LOCALITY PLAN
Scale 0 100 200 300 Feet
G.L.124
G.L.53
G.L. 52
G.L.45
G.L.48
Lode
ELLIOTT SHAFT
& CYANIDE PLANT
MAIN SHAFT
TRANSVERSE SECTION
E.
MAIN SHAFT
W
70' No. 1 LEVEL
150' No 2
236' No 3

PLAN AND SECTIONS OF THE LACHLAN GOLD FIELDS CO'S MINE FORBES

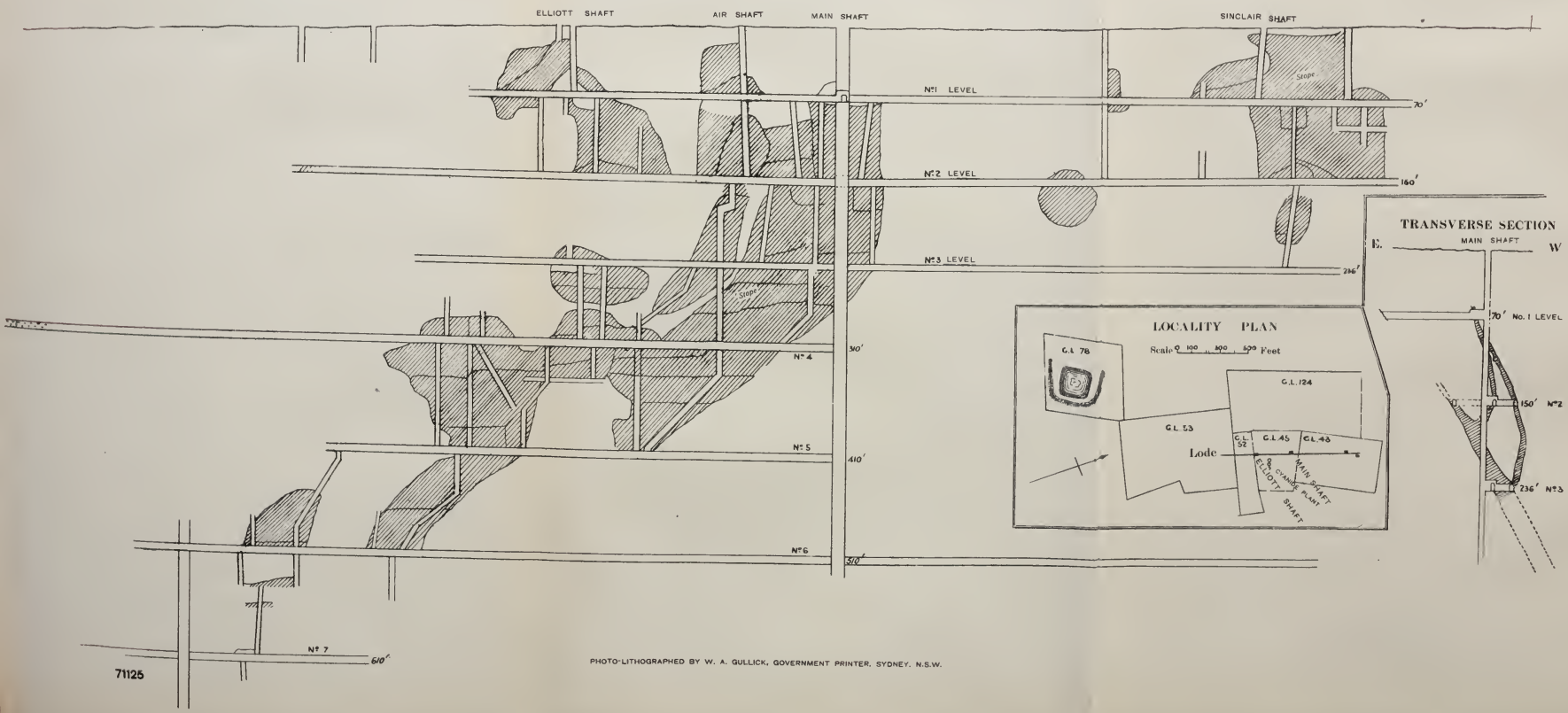
Taken from Mine Manager's Plan

Scale 0 40 80 120 160 Feet

PLAN OF WORKINGS



LONGITUDINAL SECTION



TRANSVERSE SECTION

LOCALITY PLAN

Scale 0 100 200 500 Feet

71125

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

According to Mr. Sanderson, the very large large lens of stone known as the "Cellar" yielded about 15 dwt. per ton.

At a depth of 230 feet the suphides in the stone varied in value from 15 dwt. to 1 oz. of gold per ton.

The following notes are based upon information contained in the various records of the Department of Mines. Possession of Sinclair's Reef was taken on 28th August, 1896, and a survey of the lease was made on 10th October, 1896.

In 1897, "The Lachlan Gold-fields Company (Ltd.) was formed to work the lode. The main shaft was then down 80 feet and had reached water level. Three other shafts had also been sunk to the same depth, and 800 feet of driving had been done. Two dams, each of 5,000 cubic yards capacity, had been made, and a battery of ten head stampers was in process of construction.

In 1898, from 70 to 80 miners were employed. The main shaft had been sunk to 160 feet. At the 70-foot level the lode had been followed for 900 feet, and at the 150-foot level for 400 feet. Along these workings the lode was found to vary from a few inches to 9 feet in width. The water came in at the rate of 1,300 gal'ons an hour, A ten-head battery, with ore bins and automatic feeders, was erected, and connected with the main shaft by a tram-line. The tailings amounted to 130 tons a week, for the treatment of which three 30-ton leaching vats, two sump vats, two solution vats, and two zinc extractor boxes had been erected.

About 3,500 tons of ore were treated at the battery during the year, 1,700 tons of tailinge at the cyanide plant, and about 900 tons of slimes were accumulated for future treatment. In all, about 2,088 oz. of gold had been won since the opening up of the mine.

One result of this success was the leasing of the ground to the north along the line of the lode, and the commencement of a determined prospecting campaign. In one lease, known as Morris', which adjoined the Lachlan Gold-fields property to the north, a shaft, commenced in February, 1878, was put down 105 feet, and a drive put in 200 feet to the north during the year.

In 1899, a main shaft (10 feet by 4 feet), had been sunk to a depth of 230 feet. Long levels had been run at the 70-foot, 150 foot, and 230-foot levels.

The vein was found to be of irregular nature width, being 22 feet across at the widest part. The water in the mine was saline, and came in at the rate of 1,500 gallons per hour. The cyanide plant had been improved, and during this year consisted of three (20 ft. x 3 ft. 6 in.) sand vats, and two (20 ft. x 4 ft.) slime vats; 450 tons of sand, and 150 tons of slimes, were treated a month. During the year, 5,613 tons of stone were treated for 4,287 oz of gold.

During the year 1900, the main shaft had been carried down to a depth of 312 feet.

In 1901, the main shaft, which is situated 60 feet east of the lode, had been carried down to a depth of 390 feet A new level was run at the 310-foot level. At a depth of 150-feet a drive had been put in 1,000 feet on a massive lode. Along the 310-foot level (240 feet in length) the lode averaged from 15 feet to 18 feet in width. It had now been proved for 1,800 feet, that is, along the whole length of the property. Along the lower levels so far worked the vein material consisted of a hard bluish quartz, averaging from 15 to 30 per cent. of pyrites. Amalgamation, concentration, and

cyaniding were the methods employed in the extraction of gold. The concentrates were sold to smelting works. About one-third of the gold was recovered by amalgamation, one-sixth by cyanide processes, and one-half by concentration.

The main shaft was carried down to 420 feet duriug the year 1902, and a drive was run for 320 feet at the 410-foot level. The lode was ascertained to vary in width from a mere knife-edge or thread to 42 feet. Near the surface it had been split up into smaller lodes, but at the deeper levels these minor veins coalesced to form one large lode. 7,192 tons of stone were raised this year for a yield of 5,542 oz. of gold, of a value of £22,103.

Eighty-seven men were employed in this mine in 1903, and the shaft was carried down to a point 499 feet below the surface. More development work was carried on during this year at the 310-foot and 410-foot levels. A variation in metallurgical method was also adopted. The pulp from the battery, after treatment over amalgamating tables and over concentrators, was further pulverised in pans and subjected to a second concentration. 5,872 oz. of gold, valued at £24,882, were won during the year, and the value of the machinery at this period was £10,634.

In 1904, Mr. J. B. Jaquet, the Chief Inspector of Mines, reported as follows upon this reef:—"The main lode occurs along a contact between augite-andesite and slate, the ore bodies varying greatly in thickness. In the Lachlan Gold-mine a dyke (?) of felsite has been intruded between the augite-andesite, and ore has been found upon either side. As proved by a cross-cut at the 510 feet level, this felsite dyke is 110 feet in width. The larger ore body occurs along its line of juncture with the slate, and one of lesser importance, and which has yet to be prospected, where it junctions with the andesite.*

During the year the main shaft was sunk to a depth of 520 feet; at 510 feet a level was put in; a cross cut was run; and driving north and sonth of the shaft along the lode was carried out. Payable stone was found along this level.

Drives north and south of the main shaft, at the 510-foot level, were run in 1905, until a total length of 1,129 feet had been reached. In all 1,712 feet of driving and rising were done this year. Good payable stone was reported along the 510-foot level. Nine horizontal bore holes, totalling 716 feet, were put in from the underground workings with satisfactory results.

During this year the cyanide process was done away with, and recourse was had to a more careful method of concentration, so as to save the sulphide tailings. A "Card table" and a canvas table plant were added to the machinery, the whole plant this year being valued at £11,427.

Again, in 1906, about 1,269 feet of sinking, driving, and rising were carried out. The main shaft was carried down to 610 feet; thence the lode was driven on for 293 feet. At one point along this lowest level the lode was 35 feet wide, but of poor quality. During the year crushing, amalgamation, and concentration were resorted to, the tailings being ground in Watson and Denny pans, and re-concentrated. A new plant, comprising a roasting furnace and cyanide vats, was erected.

In October, 1906, mining operations were temporarily suspended, and during the period of subsequent inactivity, the plant was used for treating the heaps of sulphide tailings lying about the mine.

*Ann. Rept. Dept. Mines N. S. Wales for 1904, p. 66.

The Lachlan Gold fields Mine was worked at a loss during 1907—424 oz. of gold only, valued at £1,926, being won. The return from the treatment of 1,187 tons of sands was included in the 454 oz. just recorded. In August of this year mining operations were again suspended.

In 1908 very little work was done on this property, 572 oz. of gold only being won, valued at £2,071.

The company was wound up this year (1908) and its assets realised. The same year the Forbes Gold Recovery Company won 146 oz. of gold, valued at £585, from cyanidation of the tailings of the Lachlan Mine. Up till the end of 1909 this company has won 887·17 oz. of gold from cyanide processes.

A plan of the mine is herewith reproduced, showing the amount and nature of the work done, and the pitch and width of the shoots of ore. According to Mr. Sanderson (Assayer) payable stone probably still exists in the south end of the mine, while according to Mr. O'Shanassy (Underground Manager) mining operations were left off on stone of the value of from 12 to 16 dwt. per ton.

ii. The Nil Desperandum Lode.

In 1898, Morris and party sank a shaft 105 feet deep on the Lachlan Lode, immediately north of the Lachlan Gold-fields' Lease. This party also drove 200 feet along the lode and found gold. A considerable depth of alluvium had to be sunk through before reaching the vein. The lode has been proved the whole length of same, a distance of 23½ chains.* "Prior to the formation of this company various shafts had been sunk on the lode, down to 90 feet, the water level, and in each shaft gold was obtained, assaying from 2 dwt. to 2½ oz. per ton. When the various leases became the property of the company, and were amalgamated, it was decided to sink a main shaft west of the lode so as to reach it at a depth. At the present time the main shaft has been sunk 217 feet, the dimensions being 10 feet by 3 ft. 6 in., with three compartments—pump and ladder shaft and two hauling shafts—and is centred throughout its whole depth. At the 110-foot level a chamber has been cut to open east on the lode, and at the 207-foot level a chamber was opened west. A drive is being put in north from the 230-foot level along the lode. This will connect with what is known as Hollinger's Shafts, at a point 200 feet from the main shaft, and also provide ventilation. Different assays taken from the drive at the 200-foot level have given from 2 to 25 dwt. per ton. In Hollinger's Shaft there is a lode 7 feet wide at the 90-foot level."

The footwall was andesite and the hanging wall was slate. The lode had a western underlay and a strike of about 20° E. of N. The lode was proved in 1902 by the sinking of prospecting shafts along the line of lode for a distance of about 50 chains. In one shaft, namely, that near the southern boundary the lode was cut at a depth of 115 feet. A considerable amount of driving north and south was carried on thence, at this place it averaged 7 feet in width and assayed from 5 to 20 dwt. of gold per ton.

In two other shafts, still farther to the north, the lode was cut at a depth of 90 feet in each case. At these points the lode varied in width from 3 to

* Ann. Rept. Dept. Mines N. S. Wales for 1901, p. 21.

12 feet and assayed 15 dwt. per ton. The main shaft was down 217 feet at this time, and from the cap of the lode to a depth of 150 feet a ferruginous quartz was met with, which at greater depth made into sulphides. In the drives, which were run north and south at the bottom of the main shaft, a lode varying from 9 feet to 12 feet wide was proved, the assays varying from 5 dwt. to 2 oz. per ton. A ten-stamper battery was erected and Wilfley and concentrating tables and other necessary appliances were installed. A tank of 5,000 cubic yards' capacity was excavated as well as two salt-water tanks of 800 cubic yards' capacity each. A company was formed of 256 shares of £25 each, and £3,630 had been spent on the mine before the company was floated.

In 1903, the Nil Desperandum Gold-mining Company employed about forty men, and the estimated value of the machinery on the 46-acre lease was £5,840. The main shaft had been carried down to 300 feet; 170 feet of cross-cutting, 581 feet of driving and 360 feet of rising had been carried out, and a winze sunk 40 feet. The plant in this year consisted of twenty head of stamps, a concentrating plant which consisted of four percussion tables, two Wilfley tables, two Watson and Denny pans, and a 15-feet elevating wheel for lifting the sands. The total amount expended on the mine and plant until December, 1903, was £15,600. In this year 1,170 tons of stone were raised for a return of 315 oz. of gold valued at £1,100, being 175 oz. by amalgamation and 140 oz. by concentration.

In 1904 the main shaft was carried down to a depth of 420 feet; 453 feet of driving, 135 feet of cross-cutting and 240 feet of rising were also carried out during the year. Developmental work was done mainly, and no crushings were made for nine months in the year. Good sulphide ore was reported from the 400-foot level south. A width of stone here of from 6 to 14 feet was met with, an average assay value of 14 dwt. A large amount of gossan ore, reported to be worth 10 dwt. per ton, existed in this mine in 1904.

The company proposed to erect both an Edwards roaster and a cyanide plant.

In 1905, 1,689 tons of stone were treated for a yield of 693 oz., valued at £2,272. On the 10th of December the mine was closed for reconstruction, and since that date no work appears to have been done on this lease.

iii. The North Lachlan Lode.

The existence of the lode of this name was foretold by alluvial miners who had been working along the Bald Hill Lead. In tracing the latter to the west the ground became more shallow, and the presence of a feeding lode was suspected. The lode when exposed exhibited features similar to those possessed by its continuation to the south known as the Nil Desperandum and the Lachlan. It has been determined by an intrusion of andesite into schistose slates, and replacement of country by lode material is a characteristic feature. Large chambers of ore have thus been formed, which are decidedly of pyritic nature below water level.

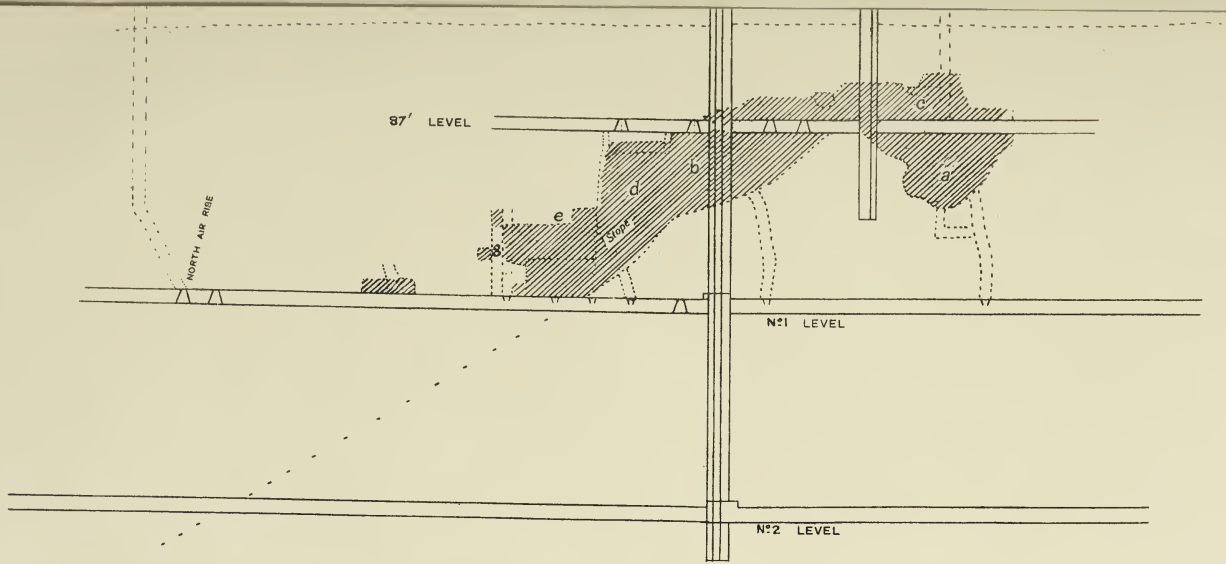


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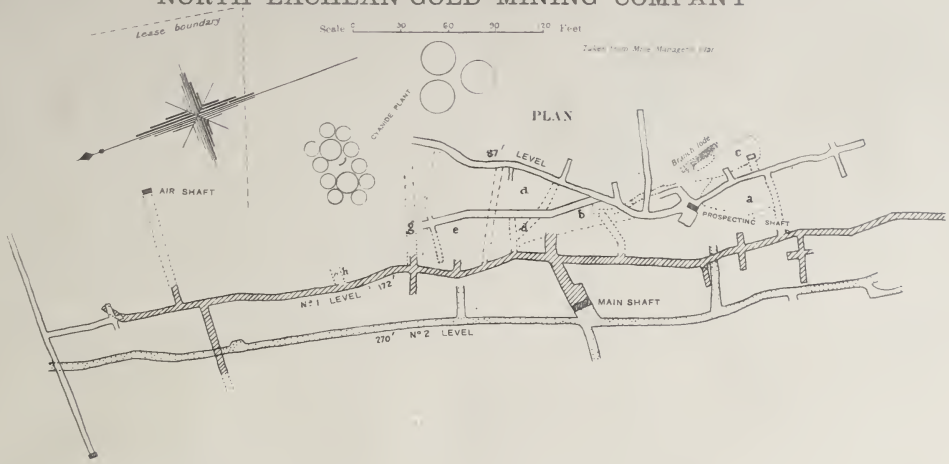
PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

PLAN AND SECTION OF WORKINGS OF THE NORTH LACHLAN GOLD MINING COMPANY



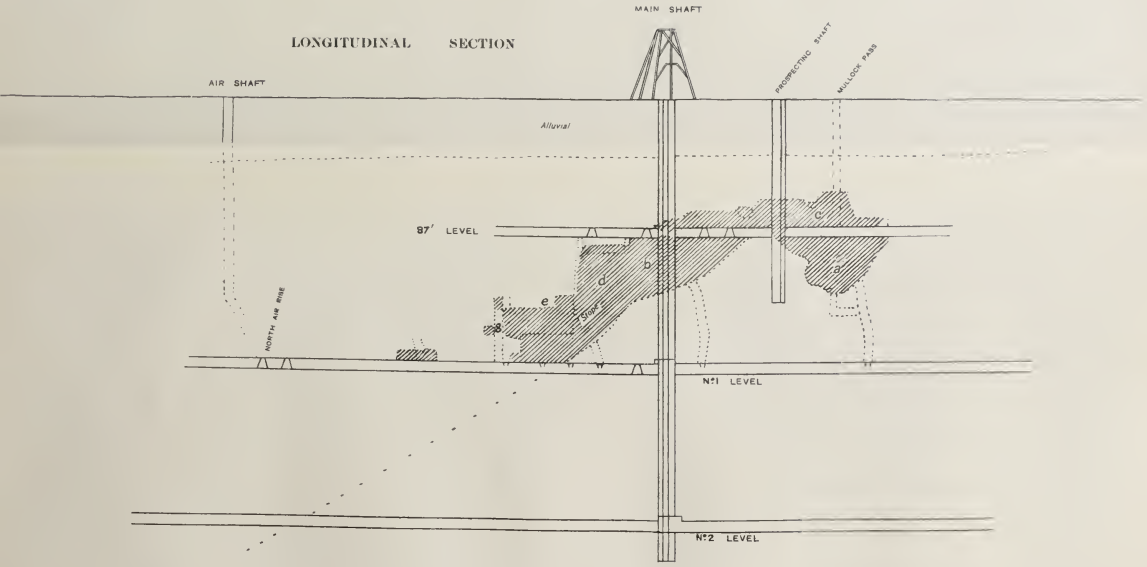


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PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

The following sketches from measurements supplied by Mr. A. L. Brain illustrate both the general appearance of an ore chamber and the general relations of the ore to the country :—

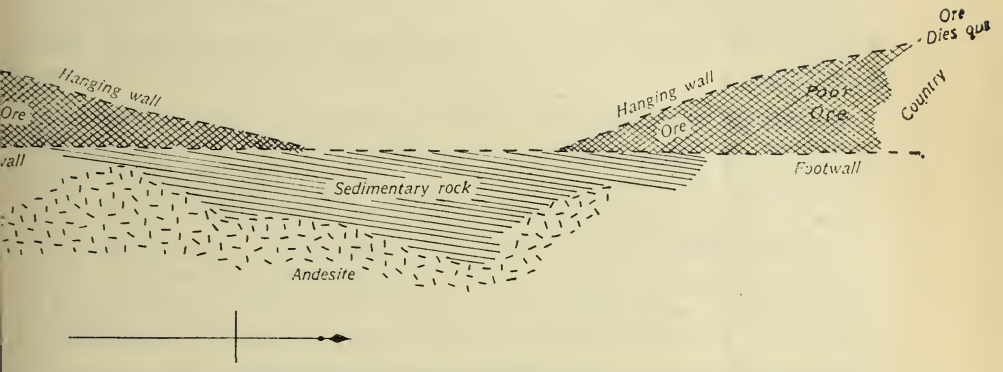


Fig. 7a.—Ideal plan showing association of lode and country at one spot in the North Lachlan Mine.

"In 1901 an area of 30 acres was leased along the Lachlan Lode immediately north of the leases belonging to the Nil Desperandum Company. This lease embraced 2,870 feet along the course of the lode. During the same year a considerable amount of prospecting was done, and the assay values contained were considered very satisfactory. A main shaft was sunk to a depth of 127 feet, and at the 87-foot level, a cross-cut, which was put in opposite to the shaft, proved the lode to be 14 feet wide at that point.

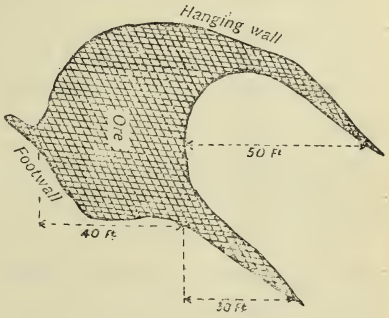


Fig. 7b.—Section across large ore lens in North Lachlan Mine; based on measurements supplied by Mr. A. L. B. Brain.

"In May, 1902, mining operations were commenced by a London company, known as the Hauraki Gold-mining Company. Their leases were 45 acres in extent. Previously to this a syndicate of local shareholders had prospected the lode. By them it had been developed to a depth of 20 feet, at which point heavy water had forced them to discontinue work. The new company immediately set to work to prospect the whole course of the lode which ran through the leases, a distance of 2,870 feet along its strike.

"A 20-horse-power double cylinder hoisting engine, with double winding drums, has been erected, and substantial poppet heads 48 feet high constructed over the shaft. A powerful and complete pumping engine and Cornish pump have also been installed and fitted up with all necessary appliances. Steam power is supplied by a 25-horse-power Cornish boiler, with a steam pump and line of pipes to convey the water from the reservoir to the works. Two 6,500 yard tanks have been excavated, and provision made for the storage of upwards of 3,000,000 gallons of rain-water. The main shaft on this mine, 12 feet by 4 feet in the clear, has been carried down to a depth of 170 feet. . . . . The chute of ore is from 2 to 17 feet wide, and at the 90-foot level 150 feet long."*

* Ann. Rept. Dept. Mines N. S. Wales for 1902, page 18.

In 1903, the main shaft was sunk to a depth of 288 feet, and drives were put in at the 170-foot and 270-foot levels. In the prospectors' shaft, at the 87-foot level, the load varies from 2 to 15 feet in width, and assayed in bulk at this level from 6 dwt. to 1 oz. 6 dwt. The average number of men employed was about 28, and the estimated value of the machinery in 1903 was £3,500.

In 1904 the North Lachlan Gold-mining Company—said to be formed of 600,000 2s. 6d. shares—came into possession of the mine. A 10-head battery was completed, and crushing operations were commenced in March. Cyanide works for the treatment of sands and slimes were also erected. Levels were continued at depths of 170, 200, and 270 feet, and along the latter level some irregularly-shaped masses of payable sulphide ore were opened up. The amount of stone raised was 5,036 tons, which yielded 2,062 oz. of gold, valued at £8,330. All costs of mining machinery were said to have been paid for by the end of the year out of the proceeds of the gold won.

In 1905, the amount of stone treated was 5,825 tons, for a yield of 3,786 oz., valued at £14,045. Of this amount, £4,373 had been won by amalgamation, £6,868 by cyaniding of sands, and £2,802 from the cyaniding of slimes. The ore was oxidised at and above the 170-foot level. During this year the estimated value of the machinery was £10,500.

The North Lachlan Gold-mining Company was reconstructed in 1906. No payable ore, however, was opened up that year.

In 1907 a new shaft was being sunk to cut the lode at a depth of 200 feet, and at the point where the Bald Hills alluvial lead crossed it. This was about 2,000 feet north of the main workings. 1,214 oz. of gold, valued at £1,394, were won during the year.

Since 1907 the mine has been idle.

Plans and sections of this portion of the Lachlan reef accompany the report.

iv. Iakwa Proprietary, Limited (Federal Option.)

Owing to the success which attended the prospecting campaign along the southern portion of the Lachlan Lode, a great amount of prospecting was carried on along the line of the lode lying to the north of the North Lachlan Leases. Few, if any, of these attempts were successful. The most determined among them was that which resulted from the efforts of the Iakwa Proprietary Company, Limited (or Federal Option), generally known as The Federal. For information regarding this venture the writer is indebted to Mr. O'Shanassey, one of the prospectors.

The prospecting was apparently undertaken on the advice of the Manager of the North Lachlan Mine, who saw clearly that such a long and powerful line of lode, such as the one under consideration, might reasonably be expected to extend much further to the north than the northern boundary of

the Hauraki lease, and that a payable shoot of ore might reasonably be found therein. The proposal was to sink to 450 feet, and to do a considerable amount of cross-cutting and driving thence.

The main shaft was carried down a depth of 150 feet, and upwards of 2,000 feet of driving and sinking were carried out. The lode was wide, and possessed a good footwall. The assays, however, were poor.

v. The Britannia.

The important vein of this name was worked during the very early days of the field. This is shown by the following extract from the *Sydney Morning Herald*, for December 27th, 1861. "About 400 yards to the westward of this shaft and running parallel with the gold struck, a company of miners, under the name of the Britannia Quartz Reef Company, have been granted a prospecting claim. They are at present about 16 feet down, the loose surface quartz is impregnated with gold . . . . They are now following a quartz leader dipping to the West . . . . . estimated to turn out from 1½ to 4 oz. of gold."

The lode, with its country, outcrops as a small, low lying island in the Lachlan River alluvium, an outcrop almost too insignificant in height to be distinguishable at a short distance from the surrounding plain of alluvium. The country is composed of schistose slates and of intrusive andesites. Several leads have been traced up to this lode, namely, the Madman, Grassatt's, and the Britannia, and these all appear to have derived their gold contents from the lode under consideration.

Although the vein appears to bear some intimate relation to the associated intrusive andesites, it must, nevertheless, be borne in mind that the vein material has altered the andesite itself quite as much as the slates or other rocks it traverses. In a letter addressed to the Prospecting Board in 1909, Mr. W. Brooks pointed out how large lenses of pyritic ore had been developed along the course of the lode, so large indeed, that chambers of considerable extent had been excavated therein. This suggests that metasomatism has played an important part in the formation. It may be mentioned in passing that the intrusive andesites accompanying the Britannia lode, are a continuation of the belt which stretches, with breaks, from Forbes to Parkes, and which is everywhere associated with the gold veins.

Very rich stone was obtained from the upper portion of the lode, but after reaching a short depth, the values decreased and mining operations were almost entirely suspended until the year 1885, and the shaft thus fell into disrepair. In 1885, the lode was worked, and Mr. C. S. Wilkinson, the late Government Geologist, reported on it as follows. (Ann. Rept., 1885, p. 128). "The Britannia Reef . . . . has been traced for about 2 chains in length, and worked to a depth of 150 feet and abandoned. It is said to have yielded 2 oz. of gold per ton. It occurs in diorite dipping North 31 degrees West. At about 50 degrees, and at the surface it is seen to vary in

width, up to 4 feet, as a network of quartz veins, and is stained with carbonate of copper. The strike of the diorite dyke is about North, 10 degrees East."

Mr. W. H. J. Slee made the accompanying report in 1886.* "The Britannia Reef . . . . is situated . . . . at the head of the Britannia Lead. rich quartz was obtained out of this reef some twenty years ago by Snow and party, but it was afterwards abandoned and remained so to within eighteen months ago, when another start was made by some of the very men who had abandoned the said reef about twenty years. The company have erected a small ten-stamp battery, which is driven by a 10-horse-power engine. They have crushed several large samples of quartz with payable results. That from the 90-foot, or deepest level, has so far given the best return, namely, 1 oz. 5 dwt. per ton."

The working of the Britannia was again attempted in 1888. A lode about 2 feet in width was exposed, a serviceable crushing and winding plant was erected, and a main shaft was started so as to cut the lode at a depth of 150 feet. By the year 1889 this main shaft had been sunk to a depth of 165 feet. A parcel of 240 tons was treated for a return of 330 oz. of gold In this year also another vein from 6 inches to 2 feet in width was found about 100 feet east of the Britannia Lode as originally worked.

In February, 1890, Mr. Slee reporting on a site which a portion of the Britannia lode traversed stated that "the site embraces a portion of an igneous dyke which is traversed by irregular quartz reefs, from which the gold in the alluvial deep leads close by have been derived. . . . These reefs are of very uncertain length and thickness, and not till the formation has been proved in depth can it be determined if the several reefs met with are of sufficient extent to justify working."—[P.B. 90/75].

"The Britannia Gold-mining Company struck a reef at the 200-foot level 3 feet wide, heavily charged with pyrites and showing gold freely."—[*Sydney Morning Herald*, March 7, 1890].

"Britannia Co-operative Gold-mining Company Limited, June 29. Main shaft sank 6 feet. The country is hard, dark, blue slate. Winze at 200 feet. level sunk 5½ feet. Water easy. The reef in the winze is rather irregular, about 3 ft. 6 in. wide but the stone , . . . prospects about 3 oz. to the ton.—[*Daily Telegraph*, July 4th, 1890.]

By the close of the year 1890 the company had sunk their main shaft a farther depth of 100 feet. Levels were then opened up at the 250-foot level. The lode was found to have been "split up" into smaller portions, but these were found to be not payable. A large stamper-battery was erected about this time but after spending a sum of £12,000 without any return, the company suspended mining operations the while additional funds were being obtained.

* Ann. Rept. Dept. Mines N. S. Wales for 1886, p. 106.

No work of importance was done on the Britannia after 1890 until 1899, when Mr. E. C. Whittell reported on an application for aid by a company which proposed to work the reef again. An extract is here reproduced from his report. The accompanying figures illustrating the occurrence are copied also from Mr. Whittell's report. [Papers P.B. 99-612.]

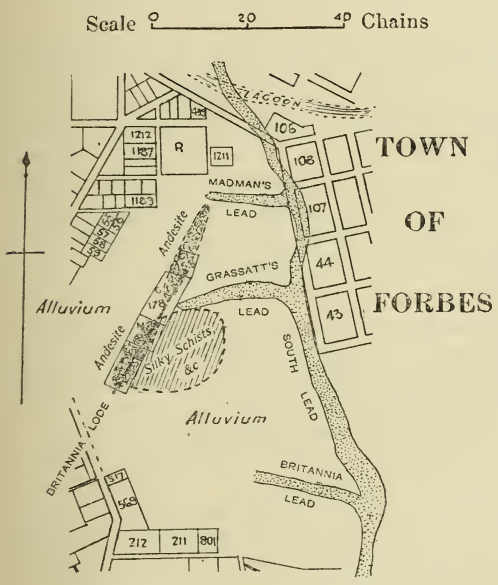


Fig. 8a.

"Diagram No. 1 shows the position of an andesitic dyke, in which occur the gold-bearing veins whose auriferous contents have been shed, forming the three leads named. Many other 'runs,' such as the Union, Caledonian, and Thompson's, have probably had their origin in this belt which appears to run through to Parkes. The Britannia Reef, running parallel to the dyke, and on its western wall, was worked some years ago, and I am informed that good gold was won, but, it is stated, the reef pinched out. About 400 feet north-east from this, applicant and party sunk a shaft in the slate to a depth of 130 feet. Then, expecting to strike a continuation of the Britannia Reef, a

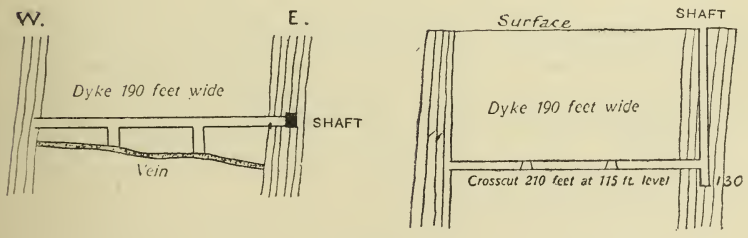


Fig. 8b.

Plan and section (*a*) Britannia Lead and (*b*) Lode.

cross-cut was put in at 115 feet, the Board aiding the party. The slate on the western wall was pierced, however, without finding the vein. From this cross-cut two cross-drives were put in, striking a reef about a foot thick. (See Diagram No. 2.) It did not contain payable gold. This undertaking—the driving—proved very expensive and slow work, owing to the water and decomposed andesite, which I am told ran like sand. They claim to have expended £876 over the work. The applicants now desire to abandon their projected southerly drive, as the country is too rotten, and desire instead to sink a new shaft from the surface to a depth of 400 feet, the spot being 400 feet northerly from A."

An application for Government aid to erect a pumping plant to clear out the shaft, and to take out a trial crushing from the 280-foot level, was made by Henry R. Johnson, in 1909. The applicant stated that the lode had not been worked for eighteen years; that a shaft at that time had been sunk to a depth of about 288 feet, but that the lode he proposed to work was a pyritic one, which had been cross-cut from the shaft mentioned at both the 200 and 280-foot levels.

This application was accompanied by a letter from Mr. E. Vanzetti, from which the following extract has been made:—"In the upper regions of the mine the lode paid well, but as time went on further capital was expended in opening up a lower region, which proved to be strongly impregnated with arsenical pyrites. At that time there was no known method of treating this class of ore, the battery alone being entirely ineffective since the foreign matter (arsenic) contained in the ore had the effect of sickening the silver, and rendering it incapable of retaining even the free gold extracted by the mill. In short, the silver and gold would not amalgamate at all, and as a consequence all the gold was lost,

"This property has remained inoperative ever since that time until now, because of the difficulty always experienced in refloating a mine which has already failed, nothwithstanding the fact that such failure was only brought about as the result of ineffective methods of treatment. . . . . In draining the Britannia mine one would be practically lifting all the water from the dyke, along the eastern wall, of which it has always been the opinion of geologists that a very rich permanent lode would be discovered at a depth. A good deal of gold-bearing ore should also be discovered along the same line in the upper or oxidised zone of this dyke, for the oxidised zone of the Britannia returned an average of something over an ounce per ton from a reef from 2 ft. 6 in. to 3 feet wide."

vi. Mary's Dream (Strickland's).

According to Mr Williams, a well-known prospector of Forbes, this line of lode was originally known as Strickland's Reef, and it is stated by some to have been the first lode worked in the Forbes District. Others, again, say that the Britannia was the first lode to be worked. Both, however, were evidently worked very shortly after the great rush had taken place to the Forbes Gold-field. The early prospector of the lode under consideration was Mr. Josiah Strickland, who, early in 1862, saw gold glistening in the quartz of the lode while looking for horses.

The lode is associated with a thick series of silky slates, possessing cleavage developed almost to the point of schistosity. The outcrop is of white cavernous and iron-stained quartz. The vein is large, 3 to 4 feet in width; the strike being almost north and south, and the underlay, which is slight, being to the east.

A shaft has been put down about 150 feet on the underlay. The gold recovered has been confined mainly to the oxidised zone. No parcels of pyritic ore have been sent away.

At various intervals, between the years 1862 and 1886, the lode has been worked more or less successfully. In 1886, Ramsay and party took out a trial crushing from this vein, which averaged 16 dwt. to the ton. In 1902, 80 tons of stone were raised.

vii. The Cripples' Reef.

Associated with the strong Strickland's line of lode are several other well-defined and parallel lodes. On these at various times prospecting for gold has been carried on with varying success. Thus, in February, 1903, seventeen gold leases were applied for along these lodes, particularly along their southern portions. The most successful claim was the Cripples', worked by Morris and party. A shaft was sunk 150 feet on the lode, and at a depth of 85 feet levels were driven 90 feet from the shaft to the north, and 100 feet to the south. The vein at this depth was about 12 inches in width. A shaft was also sunk about 200 feet to the north of the one just described, to a depth of 50 feet on a vein 4 feet in width. A battery was erected about this time to treat the stone, and a return of 240 oz. of gold was obtained from a parcel of 170 tons.

At a later period the main shaft was carried down to a depth of 240 feet.

In this mine water was not encountered at depths less than 200 feet, and the payable gold appeared to have been confined to the oxidised zone. The surface values are given as 10 dwt. to the ton. Below the surface the value of the stone is said to have been 17 dwt. to the ton. The best gold, however, was won between the 80 and 170-foot levels. Below water level a considerable amount of iron pyrites and arsenical pyrites, as also small quantities of galena, were reported. No parcels of pyrites were sent away for treatment, so that the gold contents of the pyrites are unknown.

viii. Toss of a Penny.

This lode was discovered by Alexander and party, in 1905, in the vicinity of Cripples' and Strickland's (Mary's Dream) veins. The line of the lode occurs at a little distance to the east of the Mary's Dream line. The country, as also the vein material, of the Toss of a Penny is very similar to that of Mary's Dream. Franks, Williams, and others, work the lode at the present time, and the returns herewith supplied, and taken from the annual reports, apparently refer to the gold yields obtained from this mine.

1906.—*Franks and party.*—140 tons of stone at Daroobalgie crushed for 174 oz. of gold valued at £597.

1907 (p. 14)—*W. and O. Franks* crushed 153 tons of stone from their claim at Daroobolgie for 135 oz. of gold (£473).

1908 (p. 12.)—*Williams' Claim*, Parish Dowling, 145 tons crushed for 197 oz. of gold (£727).

A battery was erected at Mary's Dream claim to treat the stone from those lines of lode. The tailings were cyanided at a later date.

ix. The Magpie and Staples' Mines.

The two mines under consideration occur from seven to nine miles north of Forbes, and on the west side of the Parkes-Forbes railway line. Both are treated here under the one heading because of the similarity of their geological occurrence. Both occur in the folded and schistose slates and tuffs of the field, and both appear to belong to the class of ore deposits known as saddle reefs. The mine workings were not accessible during the period devoted to the present geological survey of the Forbes-Parkes Gold-field, nevertheless the evidence of the surface geology points to the saddle-reef nature of the ore bodies. For a description of the latter I am indebted to

Mr. R. M. Alexander, of Tichborne. His clear statement as to the geological occurrence leaves very little doubt as to their "saddle-like" nature. Especially convincing is his description because he has not yet seen the saddle-reefs of other localities, such as those of Bendigo, Hargraves, Turondale, and Condobolin. The ideal section of the Staples' Lode has been reproduced from information supplied by the same gentleman. He describes the Staples' Reef as a narrow ridge or apex, 20 feet in width, which has a pitch and which passes downwards with steeply dipping east and west legs. "A remarkable thing," he says, "is the manner in which the slate of the surface dips against the curved planes of the apex, while the "diorite" [tuffs and arenaceous rocks.—E.C.A.] below the apex has bedding planes which dip conformally with the apex and legs of the reef." Mr. Alexander probably has mistaken the decided cleavage of the surface slates for bedding planes, a very natural error, seeing that the traces of the bedding planes of these finely-grained rocks have been obliterated by metamorphism. The more coarsely-grained strata underlying the lode have not been cleaved because of their greater strength and the traces of their bedding planes have not yet been obliterated.

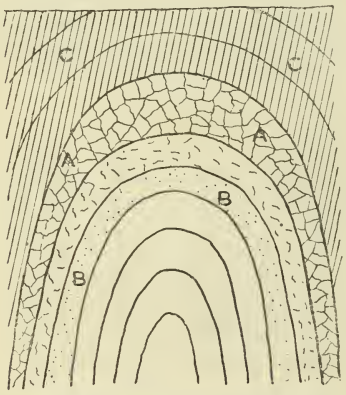


Fig. 9.—Ideal section across Staples' Reef, from information supplied by Mr. Alexander.

A.—Saddle-reefs.
B.—Tuffaceous and arenaceous sediments.
C—Silky slates showing strong cleavage.

According to Mr. Alexander, the Magpie Reefs are two parallel saddles, that is, the planes of the reefs curve sympathetically one with the other and with the bedding planes of the country. The apex of the Magpie was much wider than that of the Staples', being about 40 feet in width, and moreover "it pitched so gently," says Mr. Alexander, "that the miners could wheel their barrows along its slope." [The pitch was to the South.]

In both the Magpie and the Staples' occurrences the apices alone appear to hays produced the payable gold. In the Magpie the apex was followed downwards until a vertical depth of 45 feet below the surface was reached This clear statement of Mr. Alexander is worthy of being placed on record.

In July, 1884,* Remington and party discovered payable gold at the head of the Magpie Gully. This lode was called the Eldorado, but it was probably the same as the Magpie. The first crushing of 20 tons gave 3 oz. 6 dwt. to the ton, while a second crushing of 20 tons yielded values of 11 oz. of gold to the ton. The ore body at that time was from 2 ft. to 2 ft. 6 in. in width. A perpendicular shaft was sunk, which cut the reef at a depth of 80 feet. The payable gold was confined to the apex, but the western leg was more productive than the eastern one.

In 1885, a parcel of 220 tons from this lode was crushed for a return of 600 oz. of gold.

In 1889, the main shaft was carried down to a depth of 150 feet, and the vein worked varied in width from 6 inches to 4 feet. Many other claims were taken up on this lode, but they do not appear to have been payable.

Payable gold was also found in the apex of the Staples' Lode, but the legs were poor. About 300 tons of stone were raised for a value of 1½ oz. of gold per ton.

* Ann. Rept. Dept. Mines N. S. Wales for 1884, p. 67.

x. Minor Lodes.

Judd's Lode.—The history of this lode is but little known. It is a large quartz mass, which has a strike similar to that of the micaceous slates with which it is associated.

In 1886, Mr. W. H. J. Slee reported (Ann. Rept. 1886, p. 106) that Judd's Reef occurred about one mile north of Forbes, near the Parkes Road; that it was several feet in thickness, and that a trial crushing had yielded ½ oz. of gold to the ton. The lode has been well prospected above water level.

The Rise and Shine occurs on the North Hill at Forbes. Very rich specimens were reported from it in 1861. In 1889, a shaft was put down 100 feet, and the lode was worked by Patrick Connell and party until the close of the year 1890. Heavy water was encountered by these prospectors. In 1895, the lode was known as Pennington's. A crushing of 4 tons yielded from 4 to 5 oz. gold. Rich specimens are said to have been found at a depth of 60 feet.

Boyle's Lode.—The lode of this name is distant about two miles north of Forbes, near the head of Thompson's Lead. Formerly it was known as the Trafalgar Mine. After failures on the part of two prospecting parties to prove it payable, it was worked by Boyle, Rymer, and others in 1905. By Boyle's party it was worked for two years, and in 1907 it was again prospected by Messrs. Brain and Rymer. A crushing of 10 tons during this prospecting campaign yielded 141 oz. of gold, valued at £452. During this period the workings on the lode were carried down to a depth of between 70 and 100 feet. The gold shoots worked at this stage of development occurred in patches not more than 18 inches in width and about 4 inches in thickness.

In 1908 Boyle and Rymer obtained encouraging results. Three shoots of gold were worked, and the vein, which had been only 10 inches in width where worked by the previous party, was now found to be from 4 to 5 feet in width. From 11 tons of stone 230 oz. of gold were obtained. The shaft was also carried down to a depth of 120 feet on the underlay. The vein is of quartz and calcite; and the country is andesite intrusive into schistose slates. The strike is north 10° west, and the dip is east at from 45° to 50°. A well-defined hanging wall is present. The gangue, in addition to quartz and calcite, contains both iron pyrites and large bunches of finely-grained arseno-pyrite. The rich gold occurs in short shoots, which are said to dip south at a high angle.

B.—The Parkes Lodes.

i. The Bushman's Lode.

The lode is of quartz having an east-and-west strike and an underlay to the north. The country is of andesite, intrusive into jasperoid claystones and tuffaceous sediments. The lode was rich in the upper levels, yielding returns varying from 3 to 4 oz. to the ton of coarse gold. It appeared, however, to become impoverished at some distance below water level; nevertheless, still later prospecting operations revealed the presence of decided ore enrichments.

Mr. Inspector Hooke informs me that these enrichments are due to the junction of droppers with the main lode, the underlay of both droppers and lode being in the same direction.

The original Bushman shaft was vertical for a depth of 200 feet, at which point it cut the lode. Thence it was sunk for a depth of 200 feet on the underlay.

After a long period of inactivity, during which the mine was supposed to have been worked out, a party of tributors leased it, and during the first six months of this term they crushed 378 tons of stone for a return of 774 oz. of gold. This was in 1892. In 1893 30 men were employed on tribute, stone being extracted to the value of £5,273 (2 oz. 5 dwt. per ton).

East of the Bushman's shaft a lease had been taken up by Baxter and Saddler during this year, and they sank a main vertical shaft to the north of the lode, with the intention of cutting it at a depth of 500 feet. By December of this year (1893) the shaft had been sunk to a depth of 200 feet.

During the following year 30 men were still working the mine on tribute, and by them 1,558 tons of stone were raised and crushed for 3,972 oz. of gold. The stone was raised from the 400-foot level, where there appeared to be a shoot of gold about 470 feet in length. Baxter and Saddler now cut the Bushman lode and drove to win the rich shoot worked by the tributors who were working farther west.

In April of 1895 the tributors term expired and the mine was worked by the company. Machinery also consisting of a 20-stamper battery was erected for treating the ore. One crushing of 800 tons yielded 1,327 oz. of gold. 1,800 feet of levels were opened up this year. The area immediately west of the "Bushman's" was taken by the Bushman's Freehold Syndicate and prospected. About this time also both the old Bushman and the Baxter and Saddler's properties were amalgamated and renamed "The New Bushman's Hill."

In 1896 the main shaft was 430 feet deep and the erection of a cyanide plant was contemplated; 5,124 tons of quartz were raised which returned 5,000 oz. of gold, valued at £17,500.

During the year 1897 the shaft was carried down to a depth of 700 feet and drives were put in for a length of 1,085 feet, about 85 men being employed; 3,023 tons of quartz were crushed for a yield of 2,064 oz. gold, and 4,684 tons of tailings were treated for a yield of 562 oz. gold. A cyanide plant was also erected this year and the mine was equipped with three patent safety cages.

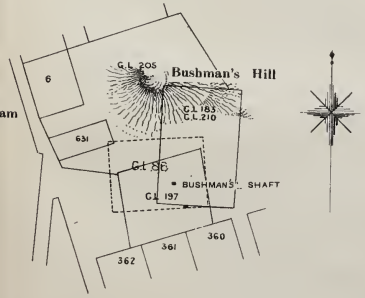
In 1898 mining operations were suspended for three months by the New Bushman's Gold-mining Company. The main shaft by this time had been sunk to a depth of 847 feet. Government aid was applied for and granted to enable the company to prove their mine at still lower levels.

The following notes, with the accompanying figures, have been extracted from Mr. Inspector Hooke's report on the mine during this year. [Papers P.B. 98-4216]:—"The workings effected consist of several shafts etc., the main perpendicular shaft being 700 feet deep at which point the vein was intersected and a level driven east and west. At a point 444 feet west from the shaft, a winze (No. 2) was sunk from this level to 846 feet and at 800 feet a level was opened and has been extended to distances of 80 feet and 126 feet east and west respectively.

The bottom of No. 2 winze is the deepest working effected in the mine, and although applicants state they propose "to further sink the main underlay shaft" they really refer to the winze mentioned herein.

PLAN OF WORKINGS
OF THE NEW BUSHMAN'S HILL GOLD MINE
PARKES

Taken from Mine Manager's Plan



LOCALITY PLAN

Parish of Currajong County of Ashburnham

Scale 0 4 8 Chains

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Under these circumstances it must be noted that everything hauled from the winze must be trucked along the 700-foot level and again hoisted to reach the surface. . . .

. . . The vein . . . exhibits all the features of a true fissure vein, and in its downward course has been subject to but little replacement, hence its further extension to a great depth may be reasonably assumed.

Its underlie is remarkably free from variation . . . . The vein inclines at an angle of 40° from the vertical and towards the north.

Laterally, the vein has been opened up for a length of about 1,000 feet; in this direction faulting has been frequent and considerable, and during the early history of the mine the peculiarities of these heaves were baffling; now however, as a result of much prospecting, no difficulty is experienced.

The position of the vein has been more or less determined beyond the boundaries of this company's claim, hence in length as well as depth the extent of fissure seems sufficient to justify expenditure on deeper exploration.

The concentration of the work in the vicinity of the winze is owing to the need of hugging a "volcanic" dyke in proximity to which the best stone has been obtained.

The gold-bearing portion of the vein contents is confined to the quartz which has been compact and continuous from the outcrop to present depth and at no time less than a foot in thickness, sometimes swelling to twice that amount.

From the surface downwards the yields were stated to vary from 5 to 3 oz., this continued to a depth of about 400 feet when a sudden drop in value occurred, after which a yield of 1 oz. was the maximum."

Mr. Hooke recommended that Government aid be granted to sink the No. 2 winze (known also as the main underlay shaft) to a depth of 1,100 feet from the surface, the average aid to be 45s. per foot from the 846-foot to the 1,100-foot level, being half the estimated cost of sinking in this hard country.

In 1899 the winze was sunk to a depth of 925 feet; the 800-foot level was extended 155 feet, and 968 tons of ore were treated for a yield of 541 oz. of gold. While sinking from the 846-foot level to the 925-foot level the prospects were discouraging, and the gold shoot was believed to have left the winze well to the east. The Prospecting Board was asked to transfer the aid from sinking below a depth of 925 feet to driving at the 800-foot level. The application was refused.

In the year following (1900), 420 tons of stone taken from the Bushman yielded 339 oz. gold. The machinery attached to the mine at this date was valued at £2,000.

In 1901 very little work was done, and 77 tons of stone only were treated for a return of 69 oz. gold.

In the following year the treatment of 365 tons of quartz yielded 219 oz go'd.

Since the year 1902 very little work has been done on this important line of lode. It must be remembered, however, with this as with the Buchanan and Phœnix lines, that in the early days of the field the miners abandoned it as being hopelessly worked out. With deeper sinking and extended mining operations, however, fresh and payable ore bodies were located. Nor can it yet be said from our knowledge of the Bushman Mine as revealed in the imperfect records here presented that it has yet been completely prospected.

An incomplete plan of the Bushman is here reproduced.

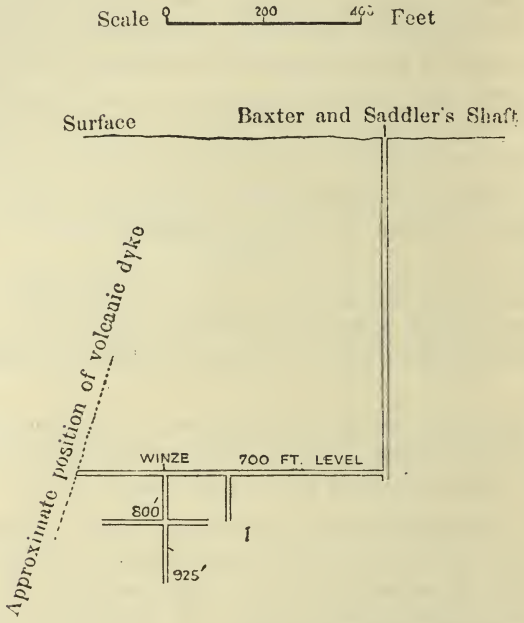


Fig. 10—Adapted from Mr. Hooke's report, illustrating method of working lower levels in the Bushman Mine.

ii. The Buchanan and Phœnix Lines.

The official information regarding the early working of these lines of lode is very meagre. The Buchanan appears to have been prospected during the early days of the field, but abandoned temporarily, and then re-opened by Messrs. Coleman, Paravicini and party, while they were working the Great Northern Lead in 1876. The country of the lode is andesite, which is intrusive into slates. Although the vein material appears dependent in some manner upon the associated andesites, nevertheless the latter have been much altered by the action of the solutions from which the vein contents have been deposited. The vein itself has a north and south strike, whereas the neighbouring lode of the Bushman has a course almost east and west. The line of lode, although of considerable length, nevertheless possesses no outcrop, being covered by a thick cap of alluvium.

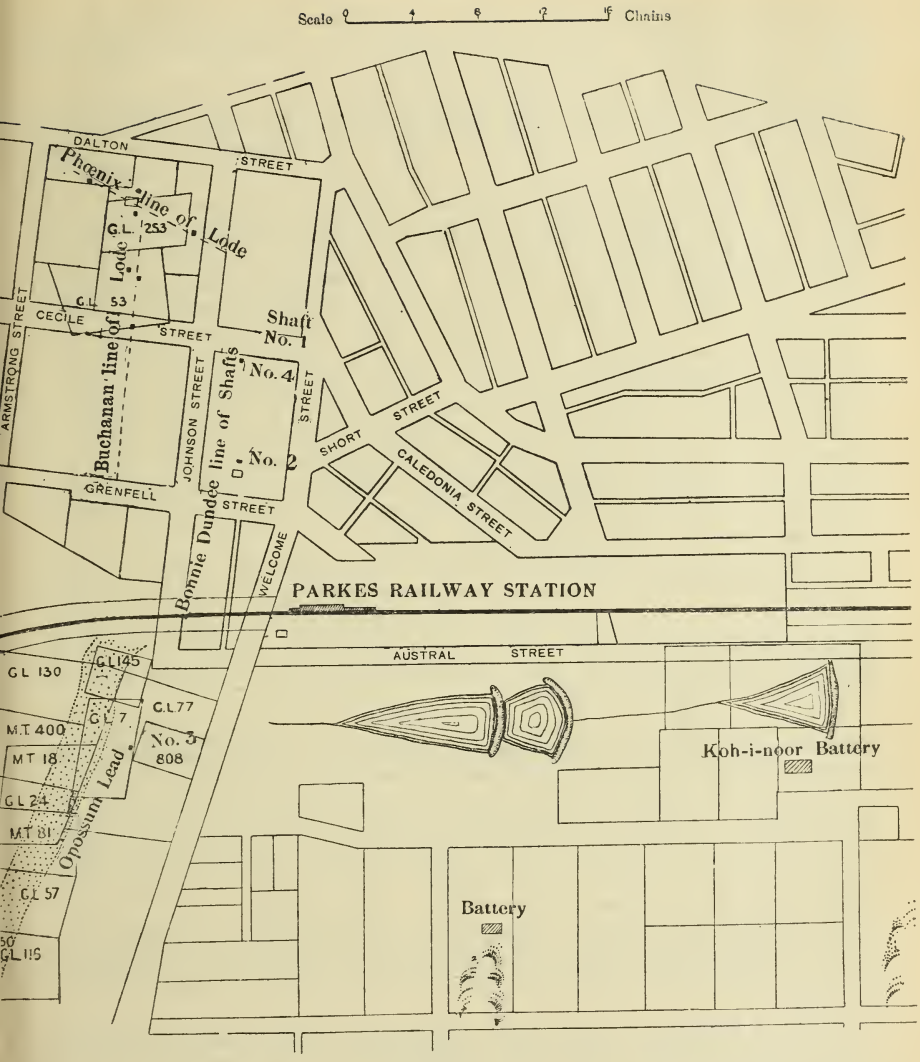


Fig. 11.

The Phœnix, on the other hand, is the same lode as the Quayle's, and cuts the Buchanan,* throwing it for a considerable distance (30 feet.)

The higher levels of the Buchanan yielded handsome returns; but between the dates 1867 and 1882 the lode was supposed to have been worked out. The Department of Mines was approached with a view to having the mining reserve cancelled in this locality, so that it might be disposed of in small allotments. That Department considered the time inopportune for alienating this land, and retained it within the mining reserve.

About the year 1882 a revival in prospecting operations took place, and the Buchanan Lode was exploited. Excellent results were obtained, especially from one claim known as "The German's."

* Information supplied by Mr. W. Leighton.

The greatest interest, however, centres round the history of Haselhurst's (Phœnix) and Quayle's Mines, which belong to the Buchanan system, and which about this time were being opened up.

Haselhurst's Mine is situated mainly on a vein which faults the long main Buchanan line of lode. The facts leading up to its working are much as follows:—Towards the close of 1883, Mr. Wm. Haselhurst took up an extended claim (200 feet x 400 feet) on the Buchanan Lode. A shaft was put down by him through the alluvium, which was bottomed at 80 feet on andesite. The stone there was not payable, and an old shaft on the line of reef was then examined by him, and a drive put in along the lode for 38 feet. This attempt also proved unsuccessful. By a careful examination, however, of the "spoil heap" belonging to this old shaft, Haselhurst was led to suspect the existence of a payable vein of quartz in the shaft itself. An old drive was found going in from the shaft, and in it a leader 6 inches in width was found. Although this appeared to be "pinching" out at this point, nevertheless, he obtained good prospects, 13 tons of stone being raised and crushed for 3 oz. of gold per ton. Haselhurst then sank a shaft at the end of his mine, and found a shoot of gold 120 feet in length. From that time onwards for years the mine became payable. Between the dates, December, 1883, and December, 1887, 6,538 oz. of gold were obtained by Haselhurst, for a treatment of 1,383 tons of stone.

In 1884, Haselhurst crushed 120 tons of stone for 800 oz. gold. Quayle and party about this time, also, took up an adjoining claim on this cross lode and raised 480 of stone, of which 237 tons yielded 700 oz. of gold. Still a third payable claim was taken up on this cross reef. In 1885 both Haselhurst's and Quayle's claims were paying well, the former winning 1,667 oz., and the latter 1,260 oz. of gold.

In the year 1885, Mr. Slee, late Chief Inspector of Mines, reported on the Buchanan line.* After mentioning the failure of the David Buchanan Gold-mining Company, through insufficient prospecting, he shows how Haselhurst found the leader, and briefly describes the character of the reef. At that time (1885), J. Quayle and party were working a vein about 100 feet from the surface, the deepest part obtained being 200 feet; and at the latter depth the vein averaged about 2 feet in width. Up till that time 914 tons of quartz from this mine had yielded 4,203 oz. retorted gold.

In Haselhurst's claim the quartz lode averaged 2 feet in thickness, the country being of soft andesite, which required no blasting; 656 tons of stone had been raised, which yielded 2,136 oz. of retorted gold, valued at £3 19s. an ounce.

Mr. C. S. Wilkinson, reporting on Haselhurst's Lode during the same year (Ann. Report, 1885, p. 128), said:—"The shaft is 105 feet deep, and the reef dips North 15° to 35° East, at from 40° to 60°. The crushing stuff up to 3 feet thick is ferruginous, with quartz occurring in shoots, one shoot being 30 feet long and 2 feet thick, thinning to each end, and dipping north-westerly at about 50°. The hanging wall shows several inches thickness of white clay, slickensided against felspathic rock, and the footwall is the same, with, in one place, coarse pebble conglomerate. The yield of 106 tons crushed in April gave 522 oz. of gold.

In this year Haselhurst crushed 390 tons of stone, and Quayle and party 750 tons, both averaging 4 oz. of gold to the ton.

During 1886, Quayle and party from their claim obtained 1,512 oz. of gold from 504 tons of quartz, and Haselhurst obtained 1,755 oz. of gold from 351 tons of stone.

* Ann. Rept. Dept. Mines N. S. Wales for 1885, p. 100.

In 1887, Haselhurst crushed 450 tons of quartz for a return of 2,745 oz. of gold.

In 1888, Haselhurst's and Drummond's were the two claims working the Phœnix Line. The former claim yielded 740 oz. and the latter 860½ oz. of gold. Quayle's claim had apparently been taken in this year by Drummond and party.

The next year, the Mining Registrar reported the greatest depth in Haselhurst's claim as 220 feet, and in Drummond's claim as 237 feet. The respective widths of the lodes were 18 and 24 inches. From the former, 483 tons of quartz yielded 2,756 oz. of gold, while from the latter claim 167 tons yielded 337 oz.

In 1890 Haselhurst sold his claim for £20,000, the new name being the "Haselhurst Proprietary Company." At this time, the main shaft was 310 feet deep, and the vein at the bottom was 5 feet wide, whereas, at 200 feet depth, it was only 8 inches wide in a shoot of stone south-east from the shaft. A 20-head stamp battery was erected, and connected with it were four Alley percussion tables, and two Arastras. Customs work was also undertaken by the company. The first crushing after the sale yielded 844 oz. of gold from 200 tons of stone. By the close of 1891 the company had their main shaft down to a depth of 360 feet, and the lode varied from 1 foot to 4 feet in width.

Since commencing operations the company had treated 1,489 tons of stone for a yield of 1,807 oz. of gold. [At this period both the Haselhurst's and the Koh-i-noor Mines were under the same management, and 110 men were employed in the two mines.]

In 1892 the only record of this line of lode is the fact that Quayle's Proprietary Company's shaft had been sunk to a depth of 395 feet.

In 1893 both Haselhurst's and Quayle's old claims were worked on tribute, but unsuccessfully.

In 1894 and 1895 the old Haselhurst's and Quayle's claims were again under tribute.

The following year Haselhurst's claim was re-named the Phœnix. During this year, the values of the stone raised were 1½ oz. of gold per ton, but the vein worked was small.

A tribute party during 1897 worked a cross-leader at the 400-foot level of the Phœnix claim. The stone yielded over 2 oz. of gold per ton, but the country was very hard. At Quayle's the same leader was being worked as in the Phœnix, where it was small but rich.

During the year 1898, the Phœnix crushed 330 tons for 370 oz. of gold, and the Quayle's Gold-mining Company crushed 64 tons for a yield of 172 oz. of gold. Work in the Phœnix at this time was confined mainly in the vicinity of the 400-foot level.

In 1899 the tributors crushed 520 tons of stone for a yield of 903 oz. of gold.

The following year twenty tributors were employed in the Phœnix claim, and 1,050 tons of stone were treated for a yield of 1,922 oz. of gold. The machinery on the lease during this period was valued at £450, and already from this claim, over £60,000 worth of gold was said to have been taken.

Immediately adjoining the Phœnix, to the east, another claim was taken up about this time on the same lode as the Phœnix. A vertical shaft was sunk 320 feet, with the intention of cutting the vein at 500 feet, and the new claim was called the East Phœnix.

In 1901 the Phœnix was taken over from the tributors and a crushing of 760 tons of stone was made, which yielded 647 oz. of gold. At the same time the Phœnix Gold-mining Company was issued in 10,000 shares at 10s. each.

In the East Phœnix the vertical shaft was carried down to 500 feet, and cross-cuts put in at various depths. Nothing valuable was found, however, during this year, the highest return being ½ oz. a ton from 36 tons of stone.

The following year a level was put in at 400 feet from the East Phœnix shaft, so as to connect the two Phœnix mines, the shaft of the original Phœnix having fallen into disrepair. The distance between the shafts at this level was 106 feet. From the 400-foot level in the original Phœnix, a winze was sunk 40 feet in the year 1903. At 500 feet a level was driven from the East Phœnix shaft to connect with a winze in the Phœnix. This drive was 170 feet long. The vein in the winze varied from 20 inches to 36 inches in width, and was valued at 18 dwt. of gold per ton. During the year 626 tons of stone were crushed for 581 oz. of gold.

Very little work was done at the Phœnix during 1904. The upper levels were let to tributors, but they soon abandoned the mine. 271 tons of stone were crushed for 205 oz. of gold during this year.

In July, 1904, Mr. William Tanner declared that the Phœnix Gold-mining Company (No Liability) had purchased the mine at a cost of £22,000 (P.B. 04–2566). No dividends had been reeeived by the shareholders, and about £7,500 had been spent in mining operations in addition to the proceeds of gold won from the mine. In 1905 gold to the amount of 258 oz. was won from 300 tons of stone. The Phœnix East Gold-mining Company was amalgamated with the Phœnix about this time, the better to test the current opinion that rich shoots of ore would be found in the lower levels of the Phœnix, in much the same way as they had been found in the Bushman Mine. Lack of capital, however, prevented any determined effort being made to prospect the lower portions of the lode. In 1906 a distance of 200 feet was driven at the 500-foot level in the Phœnix Reform Gold-mining Company's Mine (as it was called in 1905), and a considerable amount of stoping was done between that and the 400-foot level; 404 tons were crushed for a return of 418 oz. of gold during the year.

Mr. G. Smith, Inspector of Mines, reported on this lode in October, 1906. At the time of his inspection, there were three veins in the mine. Of these the main vein possessed a strike in a north-west and south-east direction, and an underlay to the south-east. Stoping was carried out along the lode in June, from the 400-foot level where the vein was 2 feet wide. It was also stoped at the 550-foot level, where it was found to be split into two portions, about 16 and 18 inches in width respectively. No. 2 was a north and south vein, and stoping was conducted on it also.

No. 3 was a branch vein having a strike east and west and an underlay to the north. This branch vein was driven on at the 500-foot level. At that depth it was 6 inches wide, and valued at 2 ozs. of gold a ton.

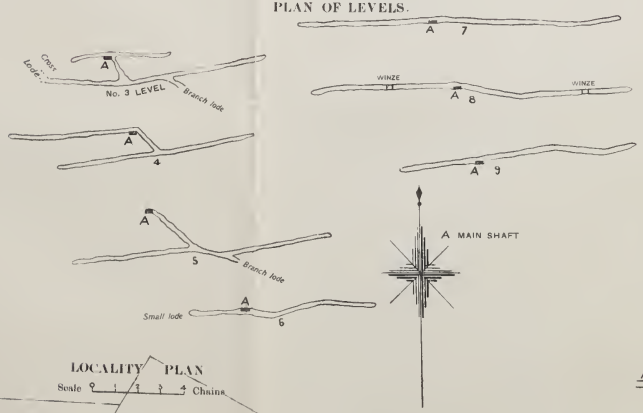
In 1907 another unsuccessful prospecting campaign was carried out; 186 tons of stone were crushed for a yield of 107 oz. of gold. The machinery at this time was valued at £1,607.

PLAN AND SECTIONS OF THE WORKINGS OF THE KOH-I-NOOR GOLD MINING COMPANY PARKES

Taken from Mine Manager's Plan

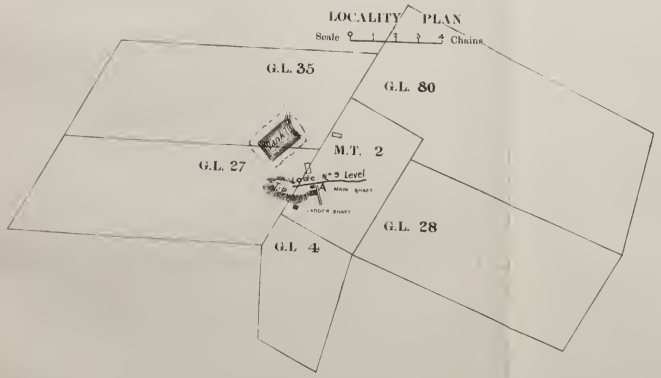
Scale 0 48 96 144 192 Feet

PLAN OF LEVELS.

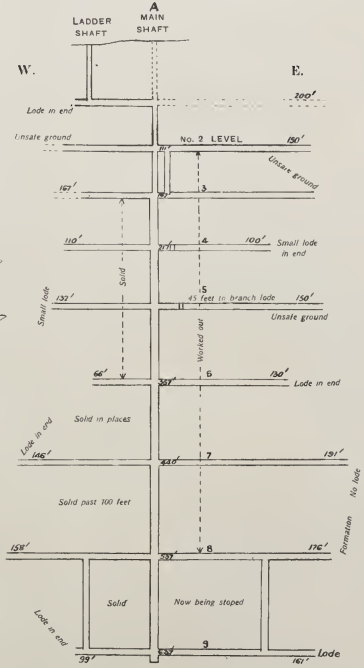


LOCALITY PLAN

Scale 0 1 2 3 4 Chains



LONGITUDINAL SECTION



TRANSVERSE SECTION

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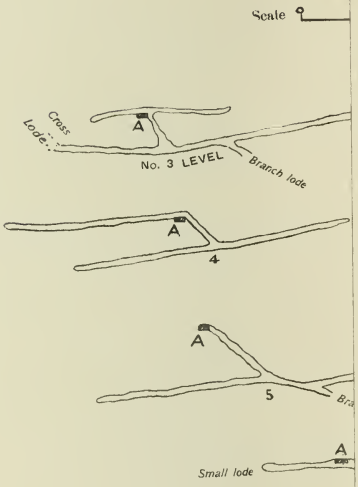
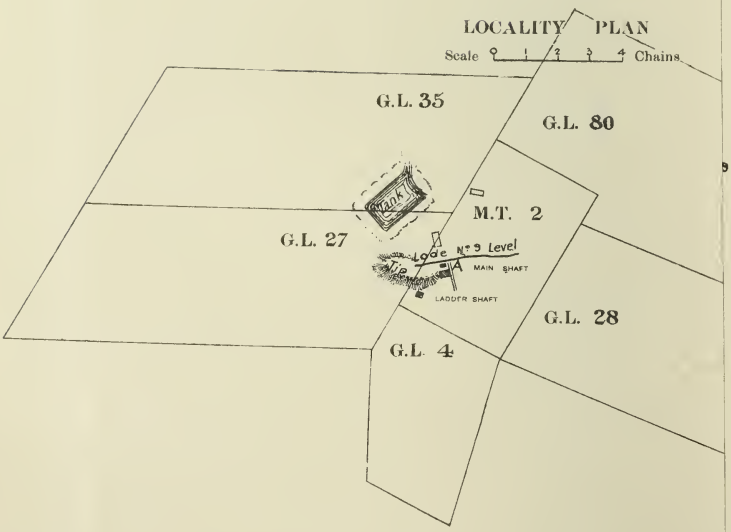
PLAN AND SECT–

KOH-I-NOOR G(





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In 1908 and 1909 a considerable amount of prospecting was carried out on a cross vein at the 400-foot level in the Phœnix Claim. The vein was large and well-defined, but up to the present the gold yields have been disappointing.

iii. The Koh-i-noor Lode.

The early history of the Koh-i-noor workings is not well known, although it is officially reported that Aaron Johnson and party discovered it about the year 1879. The vein is about 3 feet wide and was found under alluvium near the Forbes road and about one and a half miles south of Parkes. Its strike is almost east and west and its dip is to the south.

In 1887 a considerable amount of prospecting was carried out along this vein, excellent gold returns being obtained.

During the year 1889, 426 tons of stone were treated for a return of 670 oz. of gold. At this period the depth of the workings was 60 feet and the width of the lode 18 inches. The mine was sold for £8,000, and its name was changed from that of the "Old Caledonian Reef" to that of the "Koh-i-noor."

Steady progress was made in 1891, the lode being worked to a depth of 160 feet; at this depth the width of the lode was 3 feet. The company was registered in July, 1891 [22 shares each of £400] and since commencing operations 1,624 oz. of gold had been won, valued at £5,447.

From 1891 to 1898 mining operations were of an unimportant nature only.

In 1895 and 1896 the mine was worked on tribute and the men obtained good returns. By the close of 1898 further prospecting had taken place. The shaft had been sunk to a total depth of 455 feet and in doing so a payable lode had been cut from which excellent returns had been obtained. A vein subsidiary to the main Koh-i-noor was found at this level, and at their junction rich gold was obtained. During the year 2,019 tons of stone were crushed for a return of 790 oz. of gold.

The main shaft was carried down to a depth of 550 feet in 1899. At that depth a level was driven 167 feet east and 151 feet west. A cyanide plant was added to the company's outfit, and during the year 3,795 tons of stone were treated for a return of 2,271 oz. of gold, worth £8,313; 45 men were employed this year on the mine.

By the close of 1900 the main shaft had been sunk to a depth of 650 feet. The lode so exposed was 3 feet in width. The company by this time possessed a battery of twenty stampers, with a concentrating and cyanide plant, and 5,000 tons of quartz were crushed for a return of £12,000. £5,346 are reported to have been paid this year in dividends.

During the following year the main shaft was carried down from the 650-foot to the 800-foot level. The Mining Registrar reported that from the 450-

foot to the 650-foot level the mine had yielded 9 dwt. a ton, while from the 650-foot to the 750-foot level the reef had not been payable. The lode in various parts of the mine had varied from 6 inches to 10 feet in width. Mr. Inspector Hooke, in reporting upon the mine in 1901, said that a parallel quartz vein, as much as 18 inches in width was being worked on the lease, and a crushing of 39 tons had yielded 25 dwt. of gold to the ton over the plates; that 35 men were employed about the mine; and that the latter was in the hands of a company of 21,000 £1 shares. In this year also 2,605 tons of stone were crushed for 923 oz. of gold. The machinery belonging to the company was valued at £4,500.

On the 10th February, 1902, the Koh-i-noor Gold-mining Company (No Liability) made an application for aid from the Prospecting Vote to further prospect the Koh-i-noor. The following is an extract from that report. [P.B. 02–549] . . . . . The mine has been worked for the past ten years with varying results. Dividends were obtained between the surface and 300 feet, from that depth to 450 feet was blank, after which dividends were again obtained between 450 feet and 650 feet, from the latter level to about 800 feet (the present depth of the mine) the stone carried gold but not sufficient to pay working expenses; but appearances in the bottom point to another make of profitable stone which may be proved by sinking to a depth of 850 feet, and then opening out. . . . . During the time the mine has been worked the company has spent £18,420 in wages, and £1,992 in contract work at the mine, in addition to the labour of a number of men who worked the mine on tribute for three years, besides which large sums were expended in explosives, mine stores, machinery, and crushing. . , . ." Aid was granted to sink the shaft a further 100 feet and to drive thence 100 feet along the lode. Before the close of 1902 the shaft was sunk from the 800-foot to the 900-foot level, and a drive put in thence 100 feet to the east, while, during 1903, levels were driven east and west from the bottom of the shaft; 217 tons of stone were crushed for 210 ounces of gold the same year.

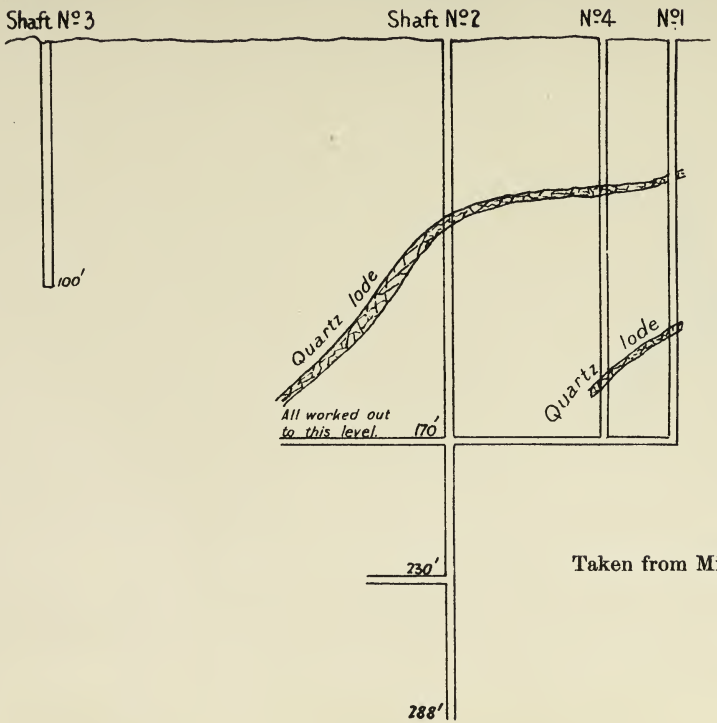
During the following year the shaft was carried down a further 50 feet. Prospecting was also carried on along both veins between the 350-foot and 400-foot levels.

At a later date the main shaft was carried down to a depth of 998 feet, but no important work appears to have been done on this reef since 1904. In 1906 a small crushing yielded 69 oz. of gold, and 6,000 tons of tailings were treated for a return of 504 oz. of gold; while in 1907 again a small parcel of 46 tons was treated for a return of 41 oz. of gold.

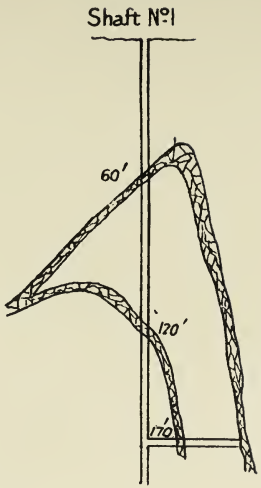
Through the courtesy of Mr. W. Tanner, of Orange, a tracing of the plans of the Koh-i-noor workings is here reproduced. From the descriptions of Mr. Tanner and Mr. Mining Inspector Hooke, it is evident that the payable gold occurred in this reef in zones more or less horizontally disposed. A similar phenomenon is reported from the Bushman Lode by Mr. Inspector Hooke.

BONNIE DUNDEE GOLD MINE.

Longitudinal Section



Cross Section



Taken from Mine Manager's Plan

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iv. The Bonnie Dundee Gold-mine.

This mine is situated in the township of Parkes. Immediately to the north of the Bonnie Dundee Leases lies the Phœnix Lode, while the main Bushman Line lies a few hundred yards to the westward,

Mr. Thomas Mitchell was one of the prospectors of the Bonnie Dundee, and he discovered the payable lode in April, 1876, at a depth of 80 feet under the alluvium by making use of an alluvial shaft in an old block claim on the Bushman's Lead. By the end of the year, 1876, the deepest shaft was 90 feet, and the lowest level was 104 feet below the surface. The width of the vein varied from 4 inches to 3 feet, and the underlay was scarcely perceptible. About 31 men were employed during the year. One small parcel of 8 tons yielded 4½ oz. of gold to the ton; one of 70 tons, and another of 982 tons yielded from 6 dwt. to 10 dwt. to the ton.

Along the southern portion of the Bonnie Dundee, Ehlers and party obtained good returns. The lode was struck at a depth of 105 feet; its width was from 6 inches to 3 feet, and it underlaid about 45° [Ann. Rept. Dept. Mines, N.S. Wales, for 1876, p. 90.] 38 tons of stone were crushed for 19 oz. of gold, and 77 tons for 22 oz. of gold.

In 1877 the lode was worked, but with only slight success.

In 1878, 444 tons of stone were treated for 450 oz. of gold, valued at £1,575.

In 1879 good returns were obtained by Medlyn and party, and in 1881 these prospectors crushed two parcels of stone from the Bonnie Dundee, one of 624 tons for 13½ dwt. of gold per ton, and one of 250 tons for a yield of 200 oz. of gold.

By March, 1882, the same party (Medlyn's) had followed the vein down to 170 feet depth on the underlay, and had driven horizontally on it for 400 feet. The vein here was 2 ft. 6 in. wide. Below the 170-foot level three winzes had been sunk on it.

"The Bonnie Dundee Reef, which was abandoned two and a half years since, has been taken up by Medlyn and party, who have crushed from it 2,773 tons of stone for 1,501 oz. 11 dwt. of gold; the vein averages about 18 inches in width; another party on the same line of reef have crushed 352 tons for 431 oz. of gold." [Annual Report, 1883, p. 13].

At a later date this property of Medlyn and party was formed into the Bonnie Dundee Gold-mining Company (Limited).

In 1885 two parcels of stone were crushed from this lode, one of 118 tons for 1 oz. of gold per ton, and 110 tons for 8 dwt. per ton.

"It is impossible for me to give you a return of the gold won from these properties, as the upper ground was worked for many years before I had anything to do with the management (of the Bonnie Dundee.—E.C.A.); but I have myself taken out 1,626 oz. from the eastern leg of the reef, and 220 oz. from the western leg near the shaft, (marked "3"), and 654 oz. from near the shafts marked "1" and "2." All stone crushed under my management would average about 14 dwt. per load."—[Extract from letter by J. Medlyn.]

The accompanying plans and sections show the amount of work done in Medlyn's claim :—

v. The Dayspring Lode.

The Dayspring was among the first of the veins discovered in the Parkes District. James Pugh had found payable gold at the Pioneer Reef in October, 1862, and the Dayspring, in its immediate vicinity was found shortly afterwards (see plan of Dayspring and Pioneer Lodes, Fig. 12.)

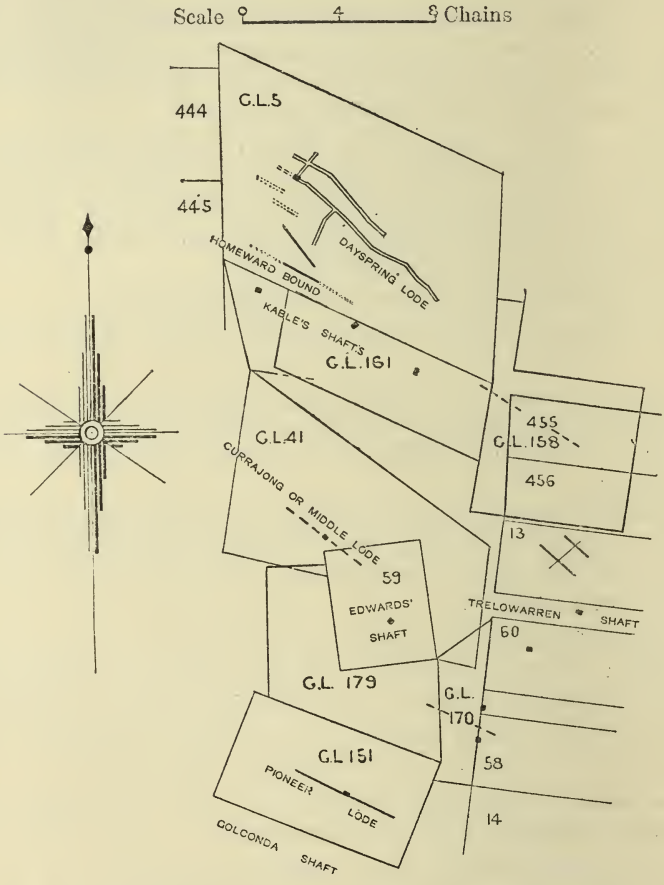

Fig. 12—Plan of the Dayspring, Homeward Bound, and Pioneer Lodes.

The lode has been worked intermittently from 1862 to the present time. By the end of 1866 all the Parkes lodes—the Dayspring included—were thought to be worked out, but at least on two subsequent occasions the Dayspring has been worked with success. The underground workings not being accessible during the geological survey of Parkes, the description of the mine has been obtained from official and other reliable records.

The strike of the lode is almost east and west, and its dip is to the north. The quartz of the lode is characteristically opaque and solid, with iron and arsenical pyrites. Fahlore is also in places associated with the gold.

It has already been pointed out that the Dayspring had been worked profitably between the years 1862 and 1866, and then abandoned temporarily. In 1872, however, the lodes of Parkes were again tried, and miners entertained great hopes of their values. Among others the Dayspring was worked, under the management of Mr. Phillip Davies, who continued to obtain payable stone till the end of the year 1875.

In 1875 Mr. Warden Dalton* reported on the mine as follows:—"The working of this mine (The Dayspring Gold-mining Company), poor as it may be, is productive of enormous advantage to this district, where reefs abound in every direction, that, if efficiently worked, will yield from 5 to 10 dwt. of gold per ton. . . . . The Dayspring Company has crushed, between the 1st of January and the 31st of December, 1874, 5,674 tons 13 cwt. of quartz; raised from a mine 250 feet in depth, and taken from a lode 2 ft. 6 in. in thickness, invested by hard blue rock, ... this stone produced 3,158 oz. 3 dwt. of gold, worth only £3 7s. 6d. per oz. . . . . The entire cost of raising and crushing the stone and extracting the gold is £1 11s. 2d. per ton. . . . . ."

In 1875 work was again discontinued, and the mine was practically abandoned until the year 1885, when 100 tons were taken from the lode for a yield of 12 dwt. gold to the ton.

In 1893 a party of tributors crushed 137 tons of gold for a return of 204½ oz. g ld. Returns from this mine had usually averaged about 6 dwt. per ton, but at the 200-foot level the much richer stone just mentioned was found.

The mine was worked also on tribute successfully during 1894.

In 1895 the mine was worked by a syndicate, who proved the vein to a total depth of 375 feet, and drove along its course at the 200-foot level for a distance of 500 feet.

In 1879 the Mining Registrar† stated that:—"The Dayspring mine embraces 30 acres of land. During the last year this company has driven 300 feet at the 200-foot level, and 250 feet at the 300-foot level; also 150 feet at the 400-foot level. They have crushed 2,500 tons of stone for an average yield of 6 dwt. per ton. . . . .

One dividend of £500 has been paid during the past year.

Again, in 1908, a crushing of 853 tons yielded 234 oz. gold.

At the close of 1899 the mine had been worked more or less continuously and successfully for sixteen years. During ten months of this year 1,052 tons were crushed for a return of 402 oz gold. The proceeds did not pay the tributors more than £1 per week wages.

During the following year the Dayspring changed hands, and was renamed the "New Dayspring." This was a no-liability company with a capital of £8,000, comprised of 16,000 shares at 10s. each, all contributing. A new shaft 12 ft. by 4 ft. was sunk to a depth of 130 feet on a vein 3 feet wide.

In 1901 the new shaft was sunk to a depth of 317 feet on the underlay, with a double tramway for the cages to the bottom. Another tramway overhead conveyed the ore to the 20-head stamper-battery, which had been

* Mines and Mineral Statistics for 1875, p. 40.
† Ann. Rept. Dept. Mines N. S. Wales for 1897, p. 33.

erected during this year. Two tanks were made, one of 1,000 yards, and the other of 1,500 yards capacity. The machinery was driven by a 40-horse-power boiler, and included two Wilfrey concentrators and a stone-crusher. Eight hundred tons of stone were treated this year for a yield of 6 dwt. of gold per ton.

In 1902 a parcel of 522 tons were treated for 196 oz. gold, and in the following year 757 tons were treated for 198 oz. gold. A rise also was put up for about 150 feet from the 288-foot level on a vein from 1 to 4 feet in thickness.

During the year 1904 470 tons of stone were treated for 186 oz. of gold. Later in the year mining operations were suspended and the machinery sold.

In the following year mining operations were confined principally to prospecting work.

In 1907 the mine was unwatered, and preparations were made for stoping at the 300-foot level.

In 1908 the gold returns were unsatisfactory, and the prospecting work also was disappointing. About 703 tons of stone were treated for a yield of 219 oz. only of gold, valued at £724.

vi. London Line.

This includes the Victoria, London, New Haven, Band of Hope, and some minor quartz lodes. The conditions determining the ore entries here differ considerably from these which gave rise to the Buchanan and other lodes associated with the long north and south line of andesitic intrusions to the east. In the one case the gold values appear to have followed the lines of contraction in the andesite and the associated sediments. In the other they appear to have been deposited along lines of powerful shearing and crushing, without the accompaniment of intrusive rocks.

The belt of country containing the London group originally consisted of both sandy and calcareous clays. During mountain-making movements these were changed, first to slates, and finally in part to chloritic slates, calcareous and micaceous schists. Along the line of crushing lenses of quartz were developed, as shown typically in Fig. 5, which was taken from the end of the open cut of the London Mine itself. In one place these peculiar eyes of quartz were parallel to, and continuous with, each other across a whole section of the mine 33 feet wide. All along the line this peculiar feature is repeated in greater or less perfection. The spaces between the quartz eyes are occupied by crushed and chloritic slate material. In general, cleavage and schist planes are observed to curve sympathetically with the reef or large quartz eyes. (See Fig. 5.)

It thus appears that the London ore body was produced by solutions which worked along zones of crushing, and that the ore body was developed during the crushing stage. Thus while the shearing and crushing operations were in progress the heated solutions of silica followed the lines of least resistance, and under conditions of great load gradually replaced the country (crushed slate) along these lines of least resistance. In this way an "augen" or eye-structure was formed by the quartz.

London Mine.—According to Mr. S. C. Woodward, the proprietor, the London was first worked about thirty-three years ago.

In 1904 the property came into Mr. Woodward's hands, and since that date he has extracted about £13,782 worth of gold.

In 1905 the lode was developed by means of an open cut and it was then ascertained to consist of an extensive low-grade formation. (See accompanying plan.)

A large lens of ore 100 feet deep and more than 50 feet in width in its central portion has been worked. It is an enlargement of a vein of quartz which doubtless will make into similar large chambers or lenses of ore at other points.

After carrying the open cut down to a depth of 100 feet a level was run beneath it. The lowest workings are 144 feet below the surface, and the stope at the bottom is 7 feet wide. An inclined tramway conveys the ore from the bottom of the open cut to a brace 50 feet high, the latter being about two chains distant to the north from the old shaft which is alongside the open cut. At first the stone was treated in lumps and passed direct from the mine to the cyanide plant. At a later date it was dropped from the brace into a rotatory rock-breaker; thence through Crom rolls, placed vertically below this in turn, until a gauge of three-eights of an inch was obtained. Thence the stone falls into large hoppers and so passes direct into four 40-ton cyanide vats. One 100-ton vat is also in use. As a result of this reduction of the stone to a much smaller gauge the extraction rose to nearly 75 per cent. of the assay value of the stone.

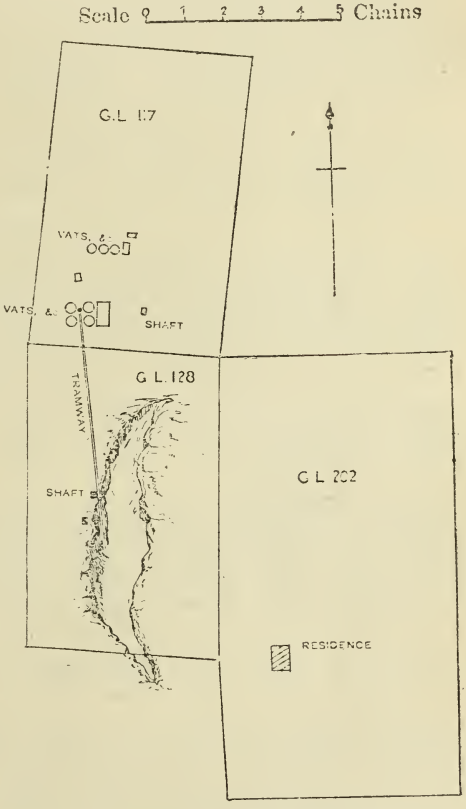

Fig. 13—Sketch plan of London open cut.

The average value of the stone is 3 dwt., and the average extraction is about 2 dwt. of gold a ton.

The machinery erected by Mr. Woodward, in 1905, was valued at £2,000. From April, 1905, till December of the same year 4,140 tons of stone were treated for a yield of 529 oz., valued at £1,682.

In 1906, 5,880 tons of stone were treated for bullion valued at £2,651.

During the following year 5,320 tons were cyanided for 779 oz. valued at £3,021, while in 1908 the cyaniding of 7,310 tons yielded gold to the value of £2,801.

In all about £13,782 worth of gold have been won from this mine up to date.

Work has been suspended here during the latter part of 1909.

The Victoria.—This property is situated a little distance to the south of the London and along the same line. It consists of a number of quartz veins traversing crushed slate country. In June, 1876, Wright and party registered a claim over the Victoria veins. A large formation was prospected, from which a crushing of 70 tons yielded 12 dwt. to the ton, one of 160 tons gave 8 dwt. to the ton, and one of 20 tons gave a return of 8 dwt. to the ton. A cyanide plant was erected at a later date, but although the veins here have been prospected from time to time nothing payable appears to have been found. Apparently with a very cheap metallurgical process this group of veins could be worked at a profit.

vii. The Birthday Lode.

The lode under consideration is situated near Bartley's Creek, about 4 miles to the south-west of Parkes. In 1896 it was worked by a company, which erected a 10-head stamper battery. Prior to this date it had been worked for some years, but not extensively. The vein is wide, and occurs as large lenses of gold quartz, alternating with very narrow portions.

During the year 1897 the company now known as the Avoca Reefs Gold-mining Company crushed 495 tons stone for 179 oz. gold from the lode under consideration.

In the early part of 1899 the Avoca Reefs Company (late Birthday Company) applied for aid from the Government Prospecting Vote [P.B., 99-3,212] to further test the value of their property. In the application it was stated that the lode was well-defined, and averaged about 5 feet in width, and that the main shaft was down 288 feet, vertical for 160 feet, at which point the reef had been cut, being 5 feet wide at this point.

From this point, it was stated also, the lode had been followed down on the underlay for 240 feet, where it had disappeared into the hanging wall. At the bottom of the shaft a cross-course had been put into the hanging wall, where the lode had been again cut, being 4 feet wide at this point. At 120 feet down, 190 feet of driving had been done; at 140 feet, the drive was 60 feet; and at 200 feet, 450 feet in length. £10,500 had been expended as wages, and the machinery on the ground cost £3,300; fifty men being employed. The request was for aid to sink the main shaft a further depth of 150 feet, and to drive 200 feet. The aid was granted. In 1900 the shaft was down 436 feet, and aid was again granted to carry the shaft down a further 50 feet. This gave a depth of 486 feet for the shaft. The prospecting was of a disappointing nature, no payable stone being discovered. The shoot of gold-bearing stone was supposed to be from 60 feet to 100 feet distant from the shaft at the 487-foot level. No further prospecting of an important nature appears to have been done on the Avoca Reef since the year 1900, and the machinery has been removed.

viii. The Welcome Lode.

The original name of this vein was the "Wild Cat." It is situated about 2 miles south of Parkes, alongside the Forbes road. The prospectors were A Knox, J. A. Davis, A. G. F. Bollinger, and W. H. Boazman. There is no outcrop to the vein, the quartz being buried beneath a thick capping of

alluvium. The strike of the lode is north-east, the underlay is one in seven, and the greatest depth attained is 300 feet. Two other shafts besides the main one have been sunk, one 95 feet, and the other 200 feet; both of these were connected with the main shaft. The length of the lode proved is 560 feet; it varied in width from 2 to 4 feet; the ore occurred in lenticular shoots; and water level is reported as being 230 feet deep.

In 1900, 1901, 1902, and 1903, about 1,800 tons of stone were treated for a return of 900 oz. of gold. Since 1904 mining operations have been practically abandoned along this line of lode.

ix. Minor Lodes of Parkes.

No access was had to the working of the mines enumerated in this chapter, with the exception of that worked by Glasheen and party in the vicinity of the township itself. The information supplied here has been obtained mainly from the Annual Reports of the Department of Mines; from the Mining Records obtained by the Inspectors of Mines; and from Prospecting Board and other papers in the possession of the Department of Mines.

The Homeward Bound Lode lies about nine miles north of Parkes, alongside the Peak Hill road. The vein, which is reported to be 18 inches in width, occurs in an area of slates and tuffs, associated with amygdaloidal and finely-grained andesites. Morrison and party were the prospectors. A shaft 200 feet deep was sunk on the lode, and 500 feet of driving was done. A five-head battery was erected at the mine, the total plant being valued at £800. . . 185 tons of stone were treated in 1901 for a return of 85 oz. of gold.

In 1902 stone was crushed to the amount of 262 tons for a return of 111 oz. of gold.

McGregor's Lode.—The official records for 1883 show that one parcel of stone taken from this mine, and weighing 27 tons, yielded a return of 160 oz. of gold, while another parcel of 40 tons yielded 64 oz. of gold. Prior to 1883 this ground had been prospected by many parties, but abandoned.

The Currajong.—Information concerning this lode is meagre. In the earlier days of the field it yielded rich returns, but these had been followed by poor ones. In 1908, Mr. J. Channon obtained 219 oz. of gold from a parcel of 703 tons of stone. Machinery of the value of £200 was erected.

The 'Possum Lodes [Caledonia Hill, Lee and party, Glasheen's, Gladstone, &c.]—In the vicinity of the 'Possum Lead a belt of andesite occurs, intrusive into the slates and siliceous claystones. Throughout the length of this intrusive belt, and in the adjoining slates also, numerous gold veins occur. Many of the veins have no outcrop at the surface, being buried under about 50 feet of alluvium, and their presence has been revealed by alluvial mining operations. They are sometimes arranged along north and

south, and sometimes along east and west lines. The andesite is altered as much by the lode material as are the slates. In many instances, in fact, the lodes may be observed to be the result of country replacement in part, and a considerable development of pyrities has been induced in the andesites adjoining the lodes. Under the general heading of the 'Possum Lodes are included the less important lodes only, the more important ones, such as the Buchanan, the Phœnix, and the Bonnie Dundee, being described elsewhere.

1. *Caledonia Hill.*—In 1877 stone from this locality yielded returns as high as 2 oz. gold per ton.

2. *Lee and party's Lode* lies on the Forbes Road, at a distance of about half a mile from Parkes. It occurs in altered andesite country and is associated with calcite, iron and arsenical pyrites. Mr. Inspector Smith states that it is of the true fissure vein type, possessing a strike running north-east and south-west and an underlay to the south-east. The depth sunk on the lode is 105 feet, and the maximum length worked is 160 feet. There was no outcrop, the surface being formed of alluvium.

In 1902, a crushing of 100 tons of stone yielded 233 oz. of gold, and in 1903, the treatment of 70 tons of stone yielded 106 oz. of gold.

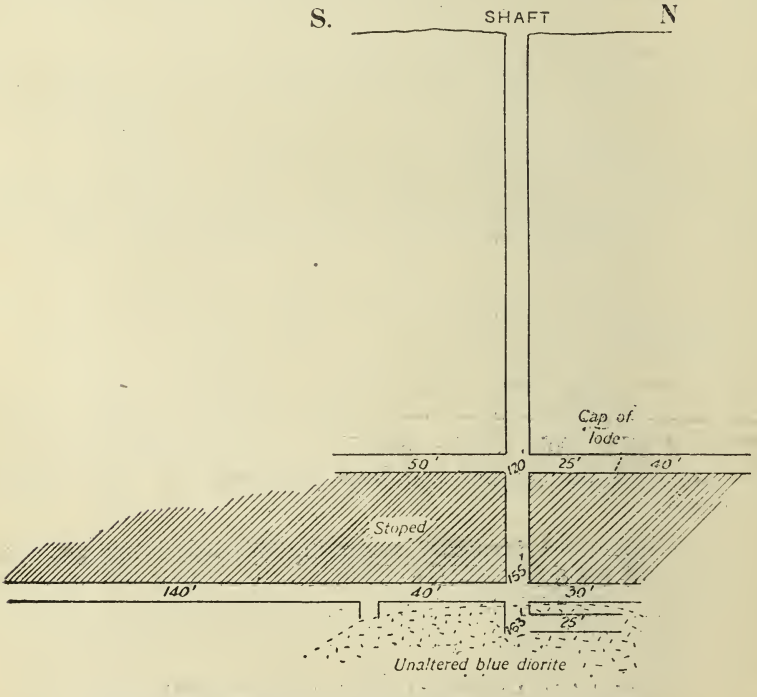

Fig. 14.—Longitudinal section of Lee and Stevens' Reef. (J. E. Carne).

3. *The Federal Lode* (Glasheen and party) adjoins that worked by Lee and party. It is a quartz vein in andesite near its junction with slates. The strike is north-east and south-west, the dip is south east, and the average width of the vein is from 10 to 15 inches. The length of lode opened up in 1909 was 60 feet, and the greatest depth reached was 220 feet.

In 1902, a crushing of 16 loads gave a return of 4 oz. 4 dwt. of gold per load. In 1903, a crushing of 70 tons yielded 106 oz. of gold, valued at £384. In 1905, the main shaft was sunk to a depth of 220 feet, and during the same year 94 tons of stone were crushed for 207½ oz. of gold, valued at £605. In 1908, work was confined mainly to prospecting. Up to the end of 1909, more than 1,100 oz. of gold have been obtained, and the average yield of the stone appears to have been about 1½ oz. of gold to the ton over the battery plates. In addition to this, cyaniding of the sands yielded returns varying in value from 3 to 6 dwt. of gold per ton.

4. *Gladstone Lode.*—Very little information concerning this lode is to be found in the official records. In the year 1890, however, two companies appear to have been working it, one of which was the Gladstone Gold-mining Company, with a capital of £10,000.

During the year 1890, the main shaft of the Gladstone Gold-mining Company was sunk from the 145 to the 195-foot level. A stope, 25 feet width, was here worked, from which 100 tons of stone were obtained, yielding 248 oz. of gold. From the 195-foot level, drives were run north and south of the shaft for a total distance of 162 feet, this work exposing a lode averaging about 2 feet in width.

In 1900, an application was made to the Prospecting Board for aid [P.B. Papers, 00–12,427] to test the lodes under the 'Possum Flat, from the 125-foot level in the Gladstone shaft. In all, 420 feet of driving were accomplished, but nothing of importance appears to have been disclosed by this prospecting campaign.

Mount Morgan.—The gold values of the mine of this name lie in a zone of crushed andesites. Quartz is present. In 1905 two shafts were sunk, each about 35 feet in depth, both being connected below the surface. Twenty-eight tons of stone were crushed for a return of 39 oz. of gold.

Nibbler's Hill.—A considerable amount of prospecting has been carried on in this locality. The hill is composed of silky and schistose slates, intruded by andesites. Near the junction of the two types of country a number of quartz veins occur. Splendid results were obtained from the surface stone, but after prospecting to depths exceeding 100 feet, the miners abandoned the spot. Several shallow "leads" take their origin in these gold veins.

The Old Welcome Lode.—Very little reliable information exists as to the working of this lode. It was one of the first which was worked in the Billabong (Parkes) Field during the year 1862. It occurs in a belt of andesite possessing flow structure. The stone in the oxidised zone was reported to have been very rich. Mr. Tanser is at present prospecting one of the veins.

Ben Nevis Reef.—The following notes have been copied from a report made by Mr. J. E. Carne, Assistant Government Geologist (94–2021).—"In the year 1894 the Ben Nevis Lode was worked by S. Woodward and party.

The lode, which occurs about a quarter of a mile to the north of the eastern end of the Ben Nevis Lead, is in slate country; its strike is about north-east and south-west, with a westerly underlay. Four shafts, in 1904, had been sunk on the lode within a distance of 50 yards, and payable stone had been worked to the 100-foot level. The last crushing, in 1874, was said to have yielded 1½ oz. of gold a ton. The payable stone, however, was soon lost. The work done in 1894 consisted of a shaft sunk to a depth of 130 feet, and drives put in thence 24 feet east and 29 feet west. No good result appears to have resulted from this work."

The New Haven Lode lies about two miles from Parkes in a westerly direction, on a continuation of the belt of auriferous country in which the London Lode occurs. Mr. E. C. Whittell, Mining Inspector, reported as follows on this lode (Papers P.B., 99–1041).—"On the hanging wall side the country is impregnated with countless quartz veins and this material, together with the quartz reef, has been crushed. Its width is 8 feet at the surface, and 28 feet, as far as proven, at the bottom of the slope. It contains only 3 to 4 dwt. of gold per ton."

The accompanying figure is a copy of that supplied by Mr. Whittell in his report.—"A, shaft down 76 feet on the underlay—50 feet from B (see figures). B to C, stope 68 feet long, open to surface—about 55 feet deep. D, shaft 55 feet deep.

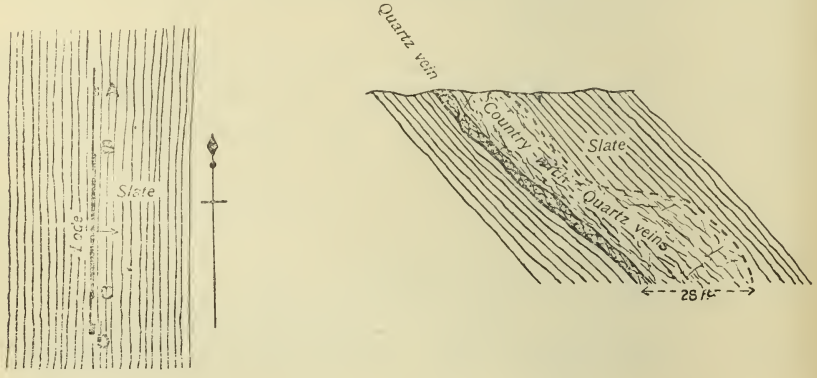

Fig. 15.—The New Haven Lode, Parkes.—A, shaft; depth, 76 feet on the underlay; 50 feet from B. B to C, stope 68 feet long, open to surface; about 55 feet deep. D, shaft, depth 55 feet.

The Mount Pleasant Mine is situated within the town of Parkes.

In 1897 two shafts had been sunk on the lode to depths of 150 and 210 feet respectively. In 1899 these had been carried down to depths of 184 ft. 6 in. respectively. Aid was granted from the Prospecting Vote to sink a winze to a depth of 232 feet from the 182-foot level.

Staples' Lode is situated between M'Guiggan's Lead and the Blue Reef. Mr. J. E. Carne reported as follows on this lode in 1891 (P.B., 91–1730) :— "The reef strikes N. 20 W. and S. 20 E., and varies from 3 to 12 inches in thickness, with an easterly underlay. Three shafts have been sunk on the underlay side of reef at distances of about 40 feet apart, and to depths of 40 feet, 60 feet, and 75 feet. Drives at the 40-foot and 60-foot levels have been put in. About 45 tons of stone raised are stated to have yielded from 13 dwt. to 1 oz. of gold per ton. The country rock is a micaceous slate, and picking ground to the lowest level attained." Aid was recommended to sink the main shaft from 60 feet to 100 feet, and to drive 32 feet north and 18 feet south on the reef from the 100-foot level. This work was carried out. The results obtained were satisfactory."

The accompanying sketch is from measurements taken by Mr. Carne.

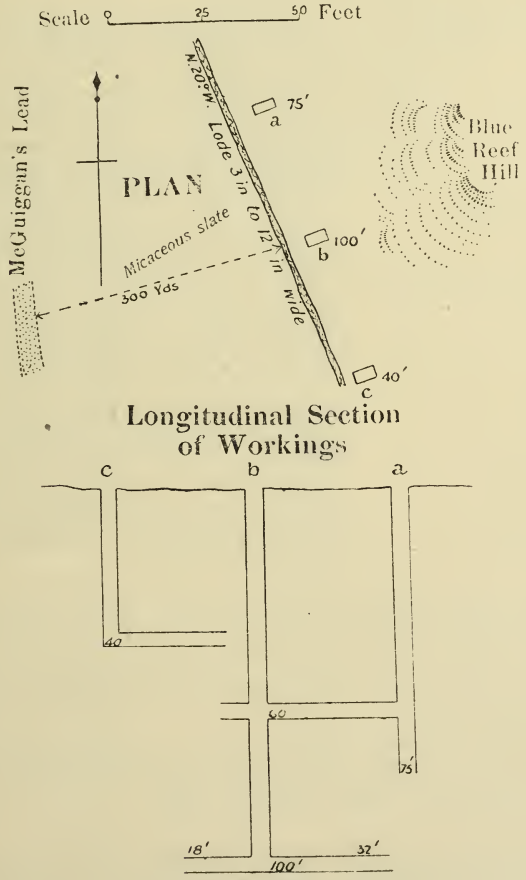

Fig. 16.
Plan and Section of Staples' Lode.

McMurray and Party's Lode.

Mr. J. E. Carne reported as follows on this property in 1891 (P.B., 91–3147) :—"The reef strikes north and south with an easterly underlay. It was first struck at a depth of 60 feet in a shaft about 20 feet south of present shaft; in the latter it was struck at 90 feet, showing a steep dip to the north. The country rock is slate, which is compact and hard at the level mentioned. The reef occurs very irregularly, in some places only a few inches in thickness, in another bulging to 3 feet. Applicants propose to sink present shaft to the 150-foot level, then to drive along course of reef 60 feet north and 40 feet south. . . . 15 tons of stone taken from this reef in adjoining shafts are stated to have yielded 20 oz. of gold."

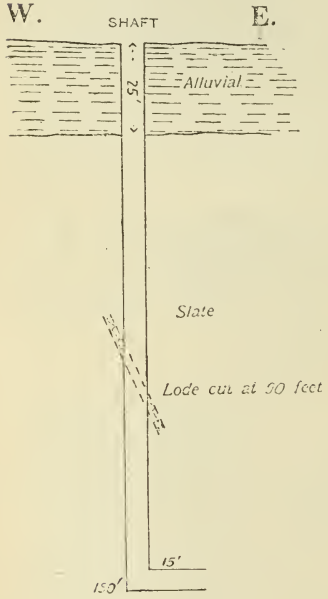

Fig. 17.

The proposed sinking and part of the proposed driving were carried out.

The accompanying figure, taken from Mr. Carne's measurements, illustrates the method of working.

Old Ramsay's Lode.—(Extracts from Report of J. E. Carne—P.B., 91–1613) :—

"The occurrence is about 2½ miles south of Parkes, in Gold Leases 98 and 99, Parish Parkes. The country is composed of contorted, cherty claystones, apparently of pre-Silurian age. The strike of the lode is about north-west and south-east, and its underlay is westerly. At the close of the year 1894 a shaft had been sunk 154 feet on the underlay. At this depth the lode varied from 14 to 20 inches in width, and yielded 7 dwt. of gold a ton at various points. One parcel of 47 tons from the lower 64 feet yielded 29 oz. 15 dwt. of gold. At a short distance from the main shaft another lode was found having a north and south strike, and a thickness of from 12 to 14 inches. The proposal, in 1891, was to sink to 250 feet on the underlay, to drive and to cross-cut at the 250-foot level for 100 feet.

The shaft was sunk to 250 feet and a drive put in thence for a distance of 102 feet, to the south-east; the width of the lode at the bottom was 18 inches; 82 tons were crushed for 14 oz. of gold. Attempts were made also to ascertain the values of the parallel quartz masses by cross-cutting.

Baden-Powell Lode is of quartz, and occurs near the junction of andesite and tuffaceous slate countries, about 1½ miles south of Parkes, along the Forbes Road. The vein is about 1 foot in width.

In 1901 about 241 tons of stone were crushed for 307 oz. of gold, and in 1902, 260 tons were treated for 780 oz. of gold, of the value of £3,000. About £6,000 worth of gold had been taken from this mine up to the end of 1902.

Barnett's Lode has not been of much value; it has been fairly well prospected. In 1890, a parcel of 16 tons gave a return of 170 oz. of gold. In 1891 it was abandoned.

The Pioneer Lode was discovered by James Pugh, in October, 1862, and here the first payable gold in the Parkes district was found.

The accompanying figure illustrates the workings as far as can be ascertained, and they are taken from a report by Mr. J. E. Carne in 1894.

The following is an extract from Mr. Carne's report (P.B., 94–2274):—"It comprises the old Pioneer Reef, near the Dayspring Reef. Applicants have cleaned out the original whip shaft at the eastern end of the old workings. This shaft is 123 feet deep (60 feet vertical and 65 feet on the underlay). At the bottom only very thin leaders are visible in the shaft; a large bunch of quartz, however, makes in a short drive a few feet to the west. Alongside the bunch a winze 6 feet deep was sunk, and 60 tons of the stone raised yielded 5 dwt. of gold per ton. On the surface, about 100 feet southerly from the shaft, a large "blow" of quartz occurs, and a small reef apparently crops out about 50 feet northerly from the same shaft."

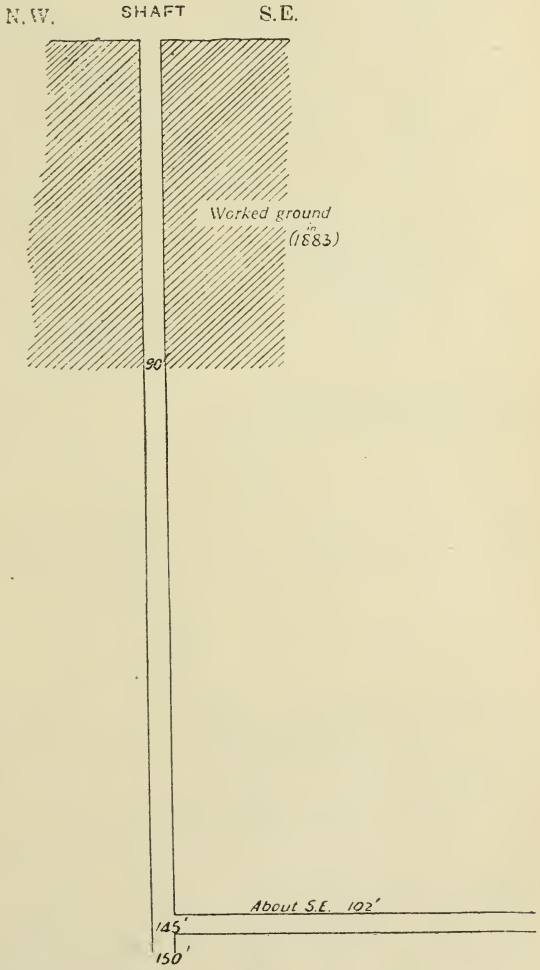

Fig. 18.—Old Ramsay Reef, M.T., 153, Parish Parkes (J. E. Carne).

The Scrub Lode and the Associated Lodes. — The Scrub, M'Guiggan's, and Blue Reefs are situated along a belt of country composed of schistose slates, associated with fissile andesites. The M'Guiggan's, the Well Tried, and other "leads" rise in this area.

Aid was granted to Spicer and company, in 1901, to continue the main shaft on the Scrub Reef to a further depth of 72 feet, the depth at the time of the request for aid being 132 feet. At 132 feet the vein was thin and pinched, but well-defined.

The shaft was carried down to a depth of 155 feet. The vein in the bottom was very narrow, and then work was discontinued. From the shaft between the depths of 132 and 155 feet the prospectors crushed 12 tons of stone for an average yield of 8½ dwt. of gold a ton.

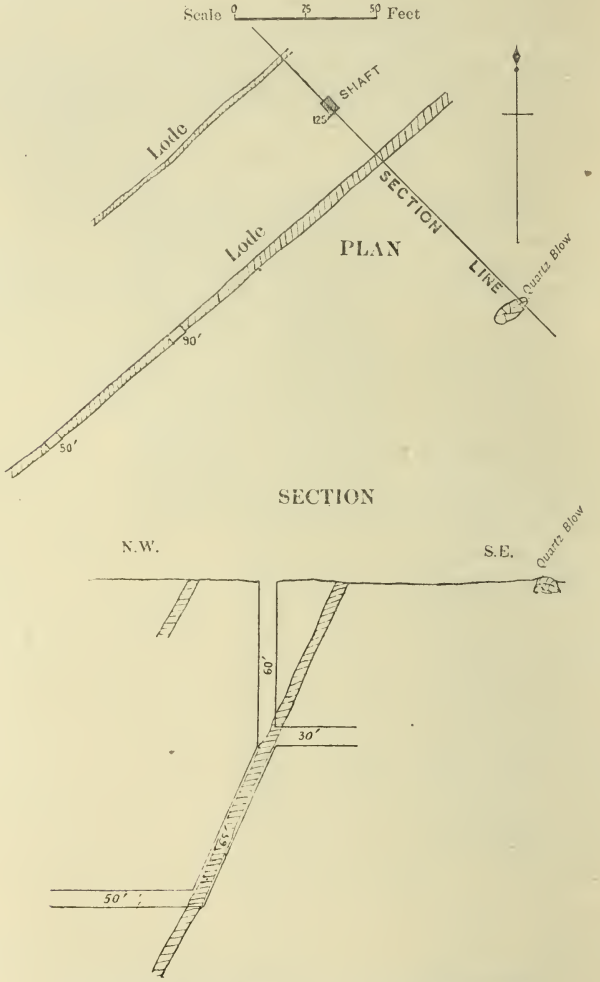

Fig. 19.—Plan and Section of Pioneer Workings (J. E. Carne).

Burgess and Smith's Mine (*Reid's Gully*).—The Reid's Gully Lodes occur here. They occur mostly as networks of small quartz veins arranged in a north and south direction, and in an area of schistose slates and tuffs. In 1896 it was reported that the "formation was about 40 feet wide, which yields 8 dwt. per load all through." [Ann. Rept. Dept. Mines N. S. Wales for 1896, p. 28.] In 1897, Burgess and Smith erected a 5-head stamper battery. During this year they decided only to follow the small veins through the andesite and slate formation. Occasionally, these were found to be very rich, but their average width could not have exceeded 1 inch.

These veins and veinlets occur along a line of andesite lavas and tuffs. The andesites in places possess a vertical cleavage and have the appearance of highly-cleaved slates. Careful prospecting has been conducted along this line for a considerable distance. The Mount Morgan quartz veins also lie along this line.

Fitzgerald's Lode.—A shaft 130 feet in depth is said to have been sunk in 1889 on this line. The lode itself is 4 feet in width. 110 oz. of gold were obtained from 65 tons of stone during the year 1889.

The Lady Jersey Lode occurs beneath the alluvium of the Tichborne Lead. The occurrence is a strong quartz vein in andesite. The following description and accompanying figure have been taken from the field notes of Mr. J. E. Carne, during the year 1891 :— The shoot of gold dips to the east. One parcel of 15 tons was crushed for 3 oz. a ton ; 148 oz. gold obtained from 148 lb. weight of stone, and 15 tons yielded 3 oz per ton. The reef is made up of four veins, which make below into one. The veins are at a distance of 1 inch only from each other. The lowest level is in solid diorite. "Over the diorite country was rich alluvial. Proposed to sink present shaft to 150 feet and then to drive along it east for 100 feet."

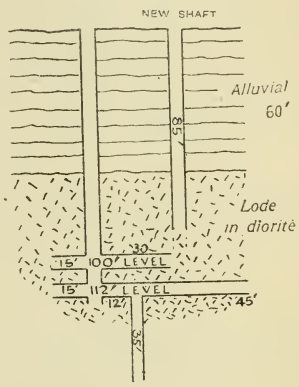

Fig. 20.—Section along Lady Jersey Lode, Tichborne (J. E. Carne).

Conclusions, as to the probable future of the mining industry at Forbes and Parkes.

A.—Forbes.

1.—*Leads.*

(*a*) From the descriptions of the South and the Caledonian Leads in the main report, it will be noted that they became less payable as they were traced downstream, beyond the limits of the auriferous belt. The gutters increased in width with progress downstream ; the wash-dirt increased in volume, and the gold became much more sparingly distributed through the drift, partly because of the enlarged cross-section of the gutter, partly because of the increasing fineness of texture of the wash-dirt, and partly because of increasing distance from the auriferous belt. The claims on the South Lead were payable as far downstream as the present Lachlan River, but at a short distance to the south of the river, the alluvial gold was found to be of too scattered a nature to pay for its extraction.

A similar condition of things appears to have been found while following the Caledonian below the Rifle Butts.

As for the channel of the old buried Lachlan River itself, one can only conclude that the probability of finding payable alluvial deposits there is very remote, for in the first place, its catchment area is enormous as compared

with the area of the auriferous belt drained by it; and, in the second place, the texture of its channel deposits were doubtless of too fine a nature in which to expect valuable alluvial deposits of gold.

These facts thus indicate that any exploitation of the downstream portions of the South and Caledonian Leads cannot be successful unless cheaper mining methods be introduced than were in existence during the period 1880-1900.

It is highly probable, however, that the Britannia lode continues to the south of the point where it passes under the Lachlan alluvium, and that it shed gold into the old main drainage line to the south of the Madman's, Grassatt's, and Britannia Leads. If this old buried main channel crosses the southern continuation of the Britannia lode, it will doubtless be enriched at points immediately down stream of the lode. The Britannia Lead is also deserving of attention along its upstream portion.

(*b*) The deep channel, about a mile and a half to the north-west of the town, was supposed by Mr. Wilkinson to be connected with the "Red Streak," a deposit of river wash about 200 feet below the surface, and lying about half a mile to the west of the town along the northern Condobolin road. No connection has ever been established between the two, probably because the mining community appear to have been misled by the appearance of the surface. Bores were put down across two small valley depressions leading from the deep shaft on the north to the "Red Streak" on the south, while the higher land between the shallow depressions was left alone, because it was supposed to be composed of rock. The whole, however, is a wide sheet of alluvium, in which side streams cut shallow depressions at the time the Lachlan entrenched itself from 25 to 40 feet deeper than formerly into the alluvial plain. This more elevated alluvium should have been bored as well as that beneath the shallow depressions.

The channel, however, in all probability, drained the non-auriferous Silurian rocks situated immediately to the west of the auriferous belt. At the same time the drainage of the auriferous belt itself appears to have gone towards the South and Caledonian Leads.

The geographical conditions therefore do not appear to have favoured the introduction of gold into this, the deepest of the Forbes Leads.

(*c*)—*The Thompson and Bald Hill Leads.*—Between the farthest point, worked downstream along the Thompson Lead and the nearest point thereto worked along the Bald Hill Leads, there appears to be a considerable area of deep and untried ground. This ground is bounded immediately to the west by the long line of the important Lachlan Lode. Whilst at Forbes I could get no certain information about this ground, nor could I ascertain whether this ground had been tested by boring. In the event of no boring tests having been undertaken, I would suggest that the area is well worthy of such a test, the plan of a proposed line of bores being indicated on the accompanying sketch of the vicinity.

2. *Lodes.*

Both the Lachlan and Britannia lines of lode appear to be worthy of further development. Replacement of country with the production of large lenses of pyritic ore has taken place along this line of lode.

B —Parkes.

1. *Leads.*

(*a*) The No Mistake, the London, the M'Guiggan, the Ben Nevis, the Great Northern, and the Welcome Leads were all abandoned as unpayable after being traced for variable distances downstream beyond the auriferous belt. Their gutters became flatter; with the increasing flatness of the gutters the wash-dirt became more voluminous and more sandy in nature, and the gold values contained therein decreased proportionately to the increasing bulk and to the increasingly fine texture of the wash-dirt. It is thus probable that the lower portions of these gutters will not pay the expenses necessary to work them under present conditions.

(*b*) It is probable that the old buried Billabong Creek at Parkes does not contain a large body of payable alluvial gold. The evidence upon which this conclusion is based is similar to that brought forward in the case of the old main drainage channel of the Forbes area.

(*c*) Bores or shafts sunk across the plain near Tichborne—both along and across the strike of the auriferous belt—may yet disclose the existence there of a payable deep lead.

2. *Lodes.*

From an examination of the literature dealing with the Parkes Gold-field, it would appear that the Phœnix, Koh-i-noor, Bushman, and Dayspring Lodes have not yet been proved to be "worked out," and it is still probable that payable shoots of ore may be found in these mines. The Birthday Lode may also be classed with those just mentioned, although it appears to be a little to the east of the auriferous belt proper.

Much of the auriferous belt is at present covered by alluvium, and payable reefs may be found in the future as the result of intelligent prospecting for alluvial gold deposits underneath the plain.

Sydney: William Applegate Gullick, Government Printer.—1910.

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NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

E. F. PITTMAN, A.R.S.M., Government Geologist.

MINERAL RESOURCES
No. 14.

THE TIN-MINING INDUSTRY

AND THE

DISTRIBUTION OF TIN ORES

IN

NEW SOUTH WALES.

BY

J. E. CARNE, F.G.S.,

ASSISTANT GOVERNMENT GEOLOGIST.

1911.

SYDNEY: W. A. GULLICK, GOVERNMENT PRINTER.

1911.

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To

T. W. EDGEWORTH DAVID, C.M.G., B.A., D.Sc., F.R.S., F.G.S.,

Professor of Geology in the University of Sydney, this work is inscribed by his friend and former colleague.

Geological Survey Branch,
Department of Mines,
Sydney, 3rd March, 1911.

Sir,

I have the honor to submit for publication a work entitled "The Tin-mining Industry and the Distribution of Tin Ores in New South Wales," by Mr. J. E. Carne, F.G.S., Assistant Government Geologist.

The tin deposits of this State are of considerable size and importance, and they have already yielded tin to the value of about £8,682,000. At the present time there is marked activity in tin-mining on account of the high market price of the metal. Mr. Carne's work, which has been prepared with great care and thoroughness, will therefore appear at a time when it will be of considerable value to prospectors and others connected with the tin-mining industry.

I have the honor to be,
Sir,
Your obedient Servant,
E. F. PITTMAN,
Government Geologist.

The Hon. A. Edden, M.L.A.,
Minister for Mines.

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III.—Geological Map of the Tin-bearing District surrounding Tingha, Stannifer, and Elsmore. Scale, 40 chains to 1 inch.

I.—INTRODUCTION.

In dealing with the Tin Industry of the State and the distribution of tin ores, the purely economic aspect is made paramount, such, in fact, being the *raison d'etre* of the Mineral Resources Series. Theoretical, and even stratigraphical geology, whilst not neglected, are subordinated to the more immediate requirements of prospecting and mining. Economic works have a tendency of late to develop into treatises on all phases of the subject, and hence become overweighted with extraneous matter properly belonging to special sections, to say nothing of the purely scientific, and frequently debatable, speculations as to genesis, which cloak the common, but more vital, issues connected with mining development.

Tin, however, unlike copper*—which formed the subject of the previous issue by the Writer—being relatively restricted in its geographical and petrological range, allows scope for consideration of more essentially scientific features, without unduly increasing the bulk of the work or obscuring its main object.

The principal centres of tin-mining have been geologically surveyed, and may be studied in the accompanying maps; those of lesser importance, and occurrences of no economic value, are shown on a general locality map.

On the geological maps the boundaries of the principal granite types are laid down; but mapping of the innumerable aplitic dykes and bosses, and their greisen and felsitic bands, has not been attempted, as the work would have been unduly delayed.

Tin ore occurs in the extreme Northern, Southern, and Western divisions of the State; but, so far, in the first only has it been found in workable quantities, and more especially on the western fall of the Northern or New England tableland; Emmaville, on Vegetable Creek, and Tingha, on Cope's Creek, being the chief centres of the tin-mining industry.

The present drainage channels in these districts were found to be extremely rich in naturally concentrated tin gravels; later, the banks and higher terrace levels were worked; and later still, the earlier drainage systems, buried beneath basalt flows, received attention, some being traced from shallow ground to gradually increasing depths beneath adjacent basalt sheets; others were attacked vertically through the volcanic rock, which was rightly regarded, in many instances, as the filling of ancient valleys.

The deep leads beneath basaltic flows, though naturally difficult and costly to trace, are destined to increase in importance as a source of tin supply, as the shallow, easily-worked deposits are denuded of their contents—a time speedily approaching since the substitution of hydraulic sluicing or dredging for the more primitive methods previously in vogue. The capital locked up in dredging plants will be freed as suitable areas are exhausted, and may probably be diverted to the deeper deposits beneath basalt cover. Already the better portions of the principal tin-bearing stream drifts have been passed through the dredge-boxes, and the end of dredging is rapidly nearing in places where recently the industry was in a favourable condition.

Tin ore is found in small quantities in the extreme south of the State, in the Snowy or Muniong Range, close to the Victorian border. In the Eastern or coastal division it occurs in extremely fine particles in beach sands, associated with gold, platinum, and monazite in equally fine division Some rich deposits of gold were worked between the Clarence and Brunswick River Heads on the North Coast, where wave action had sifted the lighter

* The Copper-mining Industry in New South Wales. J. E. Carne, Min. Res. No. 6, 2nd ed., 1903.

particles from the heavier. Further south, near the Manning Heads, Seal Rocks, Shellharbour, and Termeil, tin occurs in very limited quantity, under similar conditions and associations.

Within the coastal watershed lode tin occurs at Gundle, near the head of the Wilson River, in the Shoalhaven River valley (as stannite and oxide), and in thin veins near Bega, and which has recently been discovered in slate near Milton.

Westward it occurs—with copper—at Gumble, near Molong, at Mount Tallabung, and Burra Burra, in the Lachlan district.

In the far North-west it occurs in the Barrier Range, in coarse pegmatite dykes, intruding sedimentary rocks of Cambrian age.

In this edition of the geological map of the Tingha–Inverell tinfield, advantage has been taken of incomplete rough sketch-mapping by the late Mr. C. S. Wilkinson, F.L.S., F.G.S., Government Geologist, and Professor David in 1883, which was charted by Mr. O. Trickett, and published in 1895.

The numerous extracts from Professor David's memoir on the "Geology of the Vegetable Creek Tin-mining Field" (issued by the Department of Mines in 1887), necessary for completion of a register of occurrences, serve as references to the fuller information contained therein.

Though out of print, this work may be consulted in the Public Libraries, Universities, Departments of Mines, &c., in the various States, for the more elaborate descriptions and their context. The value of this work is borne out by the fact that twenty-three years of mining development has increased its usefulness as a local guide and reference. In no important essentials have the numerous deductions from field evidence been sensibly weakened; on the contrary, many have been confirmed and strengthened.

In a few instances, petrographical advance has rendered changes in rock nomenclature desirable, and these will be found in the new issue of the map.

The boundaries of the original map have also been extended for the sake of symmetry; gaps being filled in and right lines or natural features adopted. In these extensions, broad geological definitions only have been maintained so as to agree with the original. It has not been considered advisable to follow throughout the closer detail and exactitude adopted by Professor David in mapping the basalt covered stanniferous leads.

Reproduction of sections has been restricted to those illustrating the most important extensions of the leads.*

Professor David's Memoir has been largely drawn upon in connection with descriptions of the unproven portions of the basalt-covered leads in the Vegetable Creek district, because the same problems confront the industry as in his time, without the same opportunity of inspection as he enjoyed. Practically little has since been done to solve them. The failure of two or three attempts damped the ardour of capitalists, and the enterprise is quite beyond the means of the ordinary miner.

The rather full descriptions given of the tin lodes and their development, in the different mining fields, may seem unnecessary in view of the present abandonment of the majority; but a record is aimed at that may be serviceable to those seeking information, as well as to form a guide to the mode of occurrence.

In the preparation of this work the Writer has been greatly assisted by those interested in the tin industry—from managers and secretaries of companies to the humblest miner working in the field, and he takes this

* The shallow alluvials and channel drifts of Mole Tableland and the Gulf, which still furnish a livelihood for fossickers, are described in Professor David's Memoir, to which reference should be made.

opportunity of heartily thanking those of whom the limits of space forbids a specific mention. Without invidious distinction some special services must be gratefully acknowledged.

To Mr. E. C. Saint-Smith, Field Assistant, the Writer is indebted for hearty assistance both in the field and the office. This work owes much to his earnest co-operation, and he should share in any credit attached to it. A large part of the Tingha geological map, and the whole of the Wilson's Downfall, were geologically surveyed by him. The descriptions of individual mines and mining plants in these areas have been largely written from data personally obtained by Mr. Saint-Smith, as well as those of a number of tin deposits in the Pulletop, Germanton, and Jingellic districts. For the modified boundary of the Cow Flat (Torrington) Permo-Carboniferous outlier, the Writer is indebted to Mr. L. A. Cotton, B. Sc., Linnean Macleay Fellow in Geology.

To Mr. O. Trickett, L.S., Draftsman to the Geological Survey, the Writer is, as usual, indebted for preparation of the maps and sections, which exhibit his customary skill and care. In Mr. Trickett, the Survey is fortunate in possessing a worker whose interest is not centred merely in artistic drafting, but in the adequate illustration of the geological features and the correlation of mining details.

To Mr. G. W. Card, A.R.S.M., Curator and Mineralogist, credit is due for all the petrological determinations and descriptions embodied in the work.

The assaying and analytical work has been performed in the departmental laboratory under the supervision of Mr. J. C. H. Mingaye, F.C.S., F.I.C., Analyst and Assayer, by himself and Messrs. H. P. White and W. A. Greig.

Mr. W. S. Dun, Palæontologist and Librarian, has assisted in the editing of the work, and, as usual, has been most helpful in supplying references, indexing, &c.

Mr. L. F. Harper, F.G.S., Geological Surveyor; Mr. M. Morrison, Senior Field Assistant, and Mr. L. J. Jones, Assistant to the Palæontologist, have each aided the Writer in the collection of data.

Mr. R. H. Cambage, L.S., Chief Mining Surveyor, and Mr. J. F. Dalrymple, Draftsman, have rendered valuable assistance in connection with early mining surveys; and Mr. F. S. Mance and Mr. W. P. Geary in connection with statistical and other records.

Special thanks are due to Mr. H. M. Porter, Torrington, and Mr. J. Bergin, Emmaville, for plans and sections of the Butler, Dutchman, and Vegetable Creek Deep Lead workings, and for generous assistance.

The interest attaching to discovery of tin in commercial quantity in New South Wales, and the inauguration of tin-mining, has been greatly augmented by the contribution from the principal pioneer, Mr. C. S. McGlew, who has been long known to the Writer, but whose important part in establishing the industry was only recently learned by accident.

The Writer is no less indebted to Miss Mona Maclaine, of Clarke Island, Tasmania, for her clear exposition of the true character of the historic "black metallic particles" on the beach at Preservation Island, described by Bass in 1802.

Acknowledgment is also made for prompt and courteous assistance in research at the Mitchell Library, rendered by Mr. Hugh Wright, Librarian, and Miss M. Windeyer, Assistant.

Mr. A. H. Moore, General Manager (Messrs. Harrison, Jones, and Devlin), and Mr. E. A. Ancher, of the New South Wales Historical Society, gave interesting information with regard to the initiation of the tin industry, and as to the establishment of tin dressing at Mossman's Bay in the early seventies.

The Writer is also indebted to the following gentlemen for printed, written, or verbal communications in connection with the tin-mining industry:—Mr. W. H. Twelvetrees, Government Geologist, Tasmania; Mr. J. J. Fletcher, Secretary, Linnean Society, New South Wales; Mr. D. S. Anderson, formerly of Newstead Station; Mr. H. Selkirk, Department of Lands, New South Wales; Messrs. Saddington and Dixon; Mr. J. Gainford; Mr. T. H. Martyn; Mr. R. N. Kirk; Mr. G. S. Buzacott; Mr. W. M. Goodwin; Mr. T. Rollason; Mr. J. Mackay; Mr. A. Pearson; Mr. E. H. Shackell; Mr. T. Chandler, Emmaville; Mr. T. Hunt, Maryland; Mr. A. H. Pike, Oaky Creek; Mr. F. W. Penberthy, Elsmore: Mr. A. McGillivray, Emmaville; Mr. A. H. McEachern, Germanton; Mr. A. J. Brown, Tingha; Mr. Chas. Pattison, Tingha; Mr. J. D. Millen, General Manager; Mr. Bischoff, Tasmania; the late Mr. R. C. Alabaster and Mr. J. H. Levings, Zeehan, Tasmania; Mr. J. H. Reid, Tenterfield; Messrs. J. and W. Bennett, Tolwong; Mr. F. W. Thomson, Deepwater.

II.—DISCOVERY OF TIN IN AUSTRALASIA.

1788. New South Wales.

Probably the first reference to tin in Australasia occurs in a letter from Governor Phillip to Lord Sydney, dated 28th September, 1788:—

> "This country is supposed to have mines of iron and tin, or silver, by those who have been used to work in mines; but I give no encouragement to search after what, if found in our present situation, would be the greatest evil that could befall the settlement.
>
> "A convict, used to work in the Staffordshire lead mines, says the ground we are now clearing contains a large quantity of that metal; and copper is supposed to be under some rocks which have been blown up in sinking a cellar for the spirits. I have no doubt but that the earth contains iron and other metals, and that mines may hereafter be worked to great advantage." *

At a later date he further stated:—

> "There is neither ore nor mineral as yet found, except iron, which is very common, and a small portion of copper.†

It is possible that flakes of graphite, which are common in the Hawkesbury Sandstone, may have been mistaken for galena by the miner referred to.

It is interesting to record that the local occurrence of this mineral was noted as early as 1790, by Josiah Wedgwood, of pottery fame, in a rock specimen forwarded by Governor Phillip to Sir Joseph Banks.‡

In connection with iron, it is also of interest to record that a shipment of ten tons of local ore, selected by the official mineralogist, Mr. Humphry, was dispatched by Governor King, in 1805, for the reason given in the following extract from his letter to Earl Camden, dated 29th July, 1805:—

> "My intention in sending it is to enable a full experiment being made of its result. I, therefore, respectfully beg to suggest the propriety of its being put under the direction of Sir Joseph Banks when it arrives, to ascertain if its produce is sufficient to induce your Lordship's causing one or two persons who understand the manufacturing of iron from the ore, being sent out, which would be of the greatest national, as well as colonial, benefit." §

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* Hist. Records, I, 1783-1792, p. 190. † *Ibid.*, p. 222. ‡ Phil. Trans. Roy. Soc., 1790, XVI, p. 667.
§ Hist. Records, V, 1803-5, p. 659.

1800. New South Wales.

Another early reference to tin occurs in a letter from Dr. G. Caley to Sir Joseph Banks, dated 12th October, 1800, wherein it is stated :—

> "Iron abounds here in great abundance; I have lately received a small specimen of stone which contains copper. I have been told by a Cornish miner that he had met with tin."*

The copper may have come from Long Reef, near Narrabeen, where noticeable blue and green carbonates, and native copper, are present in the local shales; or even from near Kiama, on the South Coast, where metallic prills and plates occur in andesite.

Though extremely fine, light coloured tin oxide occurs in minute quantities with gold and platinum in the beaches at Shellharbour and Termeil, south of Port Jackson, and opposite Seal Rocks, north of it; it is improbable that it was recognised at this early date. If the Cornish miner did not mistake ordinary black iron sand for "black tin," his discovery must have been in the nearest stanniferous district—the Shoalhaven, where prospecting near Bungonia, produced a little tin ore in 1868; and where attention is again being directed by the recent discoveries at Tolwong. In 1800, however, the discovery—if authentic—must have been at the mouth of the Shoalhaven River.

1802. Tasmania.

The next reference is recorded by Collins from the "Journal of Flinders and Bass' Voyage to Tasmania" † :—

> "But, besides granite, there is on the north side, where the island (Preservation Island, north-east coast, Tasmania.—J.E.C.) is particularly low and narrow, a strip of calcareous earth, of a few hundred yards in length, which discovers itself near the surface of the water. It is not for the most part pure, for broken pieces of the granite are mixed with it in various proportions. Some parts are a mere mass of these broken pieces cemented together by the calcareous matter; whilst others are almost perfect chalk, and are capable of being burnt into excellent lime. Broken sea-shells and other exuviæ of marine animals are apparent throughout the whole mass. Upon the beach, at the foot of the chalky rock, was found a very considerable quantity of the black metallic particles which appear in the granite as black shining specks, and are, in all probability, grains of tin."

The above reference has been given in full, because it has been thought by at least one authority that the writer—Bass—"is unlikely to have mistaken grains of black mica, hornblende, or other minerals for tinstone, since he appears to have possessed considerable geological knowledge."‡ But, notwithstanding, there appears to be a strong element of doubt as to the authenticity of the discovery.

According to the Secretary for Mines, Tasmania, tin is not known on Preservation Island; it is, however, recorded on Clarke Island close by, on the south-east.§ In view of tin-mining in Flinders Island and Banks Straits it is improbable that the well-known reference to its occurrence in Preservation Island would have been overlooked by miners employed on the former; nor has it been, as will be apparent from the following correspondence.

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* Hist. Records, 1800–2, p. 239. † An account of the English Colonies in New South Wales, &c., II, 1802, pp. 147–8. ‡ A. Liversidge, Minerals of N. S. Wales, 1888, p. 77 § R. M. Johnston, Geol. of Tasmania, 1888, p. 29.

Mr. W. H. Twelvetrees, Government Geologist of Tasmania, to whom the Writer applied for confirmation of Bass' discovery, states that he communicated with Miss Mona Maclaine, of Clarke Island. In forwarding her reply, he remarked that no one would have a better acquaintance with Preservation Island than her family.

Miss Maclaine wrote :—

> "*Re* your inquiries upon Preservation Island, I can pretty confidently reply. I know the island well. I can safely say that the quantity of black metallic particles that are noticeable on several parts of Preservation Island contains extremely little or no tin. Locally called 'black sand,' as it runs out on the sea beach from the banks, like broad dark stains in the sand to look at, it has caused much comment, and has been tested many times. My brother George some time back had some analysed, and it proved to have little or no tin in it. It is too light, as well. The black specks in the rocks are what usually shows in coarse granite rock—tourmaline, people call it, but certainly not tin. No tin has ever been found on Preservation Island to our knowledge, and no sign of any formation likely to hold tin. It would have been taken up and worked if there had been ; people are very keen miners in the Straits, and they send a good lot of tin from Flinders Island every year."

Mr. Twelvetrees forwarded a sample of granite from Clarke Island which contains abundant flakes of very black biotite mica.

In a further communication Miss Maclaine states :—

> "Tin is found on Clarke Island ; a reef crops out about 3 miles inland from the coast on the north-west side of the island. It is situated about a mile below two prominent hills, and has been worked at different times by three different parties of prospectors, but has been abandoned as not in payable quantities. Water there is also scarce."

1824. New South Wales.

Probably the first authentic notice of tin in New South Wales, or indeed, Australasia, is that by W. C. Wentworth in 1824.* Writing of the mineral resources of New South Wales, he states :—

> "The fossil productions are coal, in the greatest abundance ; salt, slate, lime, granite, quartz, freestone, plumbago, potter's clay, iron ; white, yellow, and brilliant topazes ; alum, lead, tin, copper. The last three metals, however, have been found only in very small quantities ; but, as has been justly remarked in a celebrated review, the epidermis of the country has hardly yet been scratched."

Wentworth obtained his information from the journal of Dr. T. Reid, who accompanied Governor Macquarie on his tour of inspection of counties of Argyle and Westmoreland. Further on he quoted this journal *in extenso* ; additional extracts are here given evidencing scientific knowledge.

> "The subject of minerals cannot be further prosecuted in this detail. Let it suffice for the present to say that sufficient traces of lead, tin, copper, and iron have been met with, the search for those valuable metals may not be unsuccessful.†

* A statistical account of the British Settlements in Australasia, including the colonies of New South Wales and Van Diemen's Land, 3rd ed., 1824, I, pp. 4 and 5. † *Op. cit.*, p. 139.

"The indications of coal here are so unequivocal that I have no hesitation to say this valuable article may be found in abundance; traces of lead are also to be met with. On my former visit to the country I found two or three specimens of the carbonate and phosphate of that mineral near the edge of the river (Parramatta.—J.E.C.), but want of time prevented me from prosecuting the inquiry further.*

"P. 139. While inspecting this country (Wollondilly River.—J.E.C.) with Mr. T. (Throsby.—J.E.C.) I picked up some granules of copper in débris of basalt and clay-slate."

The discovery of traces of tin (probably in the Upper Shoalhaven) evidently dates between 1820 and 1824; for in the first and second editions of Wentworth's work (1819 and 1820), iron is the only metal stated to have been discovered.

1827. New South Wales.

P. Cunningham, in 1827, also referred to the reported occurrence of tin in New South Wales in the following passage :—

"I have seen specimens of copper from Bathurst, and from near Port Hacking, in Cumberland (county.—J.E.C.), and tin and lead are also stated to be contained in portion of our continent."†

1845. New Zealand.

In 1845 tin ore was recorded in New Zealand.‡ Two copper mines were opened near Auckland :—

"Besides copper and manganese, tin, lead, and nickel, are reported to have been discovered." In 1846, tin, zinc, lead, copper, and mercury are recorded as having been found.§ It is probable the tin was from Stewart Island.

1846. South Australia.

In 1846, F. Dutton recorded discovery of tin ore in small quantity in South Australia.‖

1849. New South Wales.

In this year the Rev. W. B. Clarke predicted the discovery of tin in New South Wales in a letter to the *Sydney Morning Herald* of the 16th August, 1849 :—

"And here, merely for the sake of usefulness, we suggest that though tin has not yet been found in the colony, it may hereafter be discovered. It is not improbable that it will be found along parts of the Murrumbidgee, where granite occurs with abundance of schorl, since, in granite districts of Cornwall, oxide of tin has a marked connection with schorl, which latter mineral is a principal ingredient in the tin lodes. The writer of this suspects, however, that he has found crystals of tin in granite from the locality mentioned, though he did not pay particular attention to the fact."

Mr. Clarke's reference is given in full because of an erroneous impression that he actually discovered tin in the year mentioned."¶

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* Op. cit., p. 131. † Two Years in New South Wales, 1827, pp. 344-5. ‡ Mining Journal, XV, 1845, p. 478. § *Ibid.*, XVI., 1846, p. 221. ‖ South Australia and its Mines, 1846, p. 263. ¶ Liversidge, Min. Prod. New South Wales, 1882, p. 101; Minerals of New South Wales, 1888.

At a later period Mr. Clarke definitely fixed the date of his discovery :—

"In 1851–3, when I discovered the first tin in the colony." *

He apparently overlooked the fact in defending his claim as the first discoverer before the Royal Society in 1872, when he claimed that tin had already been named by him as a product of the colony as early as 1849. †

It may also be remarked that the close association of tin and schorl has not been established in this State; while it occasionally occurs in alliance, or in the granite host (as at Giant's Den, near Bendemeer, and elsewhere), it is completely overshadowed by the more abundant mineral chlorite, which is a marked feature of the tin veins of Mole Tableland and New England generally. Nor has the prediction as to locality been verified in a commercial sense; in only one site in the watershed of the Murrumbidgee has tin been found—Sandy Creek, about 18 miles east of Tumut—and there in extremely limited quantity.

1851. New South Wales.

In 1851 the Rev. W. B. Clarke recorded his first authentic discovery of tin ore in New South Wales. In his Seventh Report, dated Jindebain (Jindebyne.—J.E.C.), 24th December, 1851,‡ writing of the Snowy Range, he stated :—

> "The tourmaline places the granite not far from that of Dartmoor, and one might expect tin in the vicinity. I obtained one small specimen from the granite; none was, however, found amidst the detritus."

Both lode and stream tin were subsequently discovered in 1875, near the Pilot Mountain, on the main Snowy Range, but, so far, not in payable proportions.

1852. South Australia.

T. Lancelott recorded "Sulphurate (sic) of tin and oxide of titanium being found in the Barossa Range, S.A."§

W. Hughes also records tin amongst the minerals discovered in South Australia.¶

1853. Victoria.

Brough Smyth states that tin ore was first recognised amongst black sands brought from the goldfields of Victoria, by Mr. George Foord, on the 11th March, 1853.§

G. M. Stephen, in a letter to the Melbourne *Argus*, of the 31st March, 1853, mentions tin oxide at the Ovens Goldfield.

1853. Tasmania.

Thomas Moore, in a paper read before the Royal Society of Tasmania, on the 11th May, 1853, records tin in Tasmania. From a collection of Tasmanian minerals, Mr. Moore sent a selection of what he regarded as the most valuable to Mr. T. W. Wilson, a practical geologist in Yorkshire, with a request to name and describe. From Mr. Wilson's letter in reply, Mr. Moore quoted, amongst other items :—

> "No. 25, Tinstone.**—As regards the tinstone, I need not remind you of its value. If you can open a mine as rich in tin as this specimen, you will be very fortunate in the mining department."††

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* Sed. Form. New South Wales, 1878, p. 106. † Anniversary Address, Trans. R. Soc. N. S. Wales for 1872, VI, p. 28. ‡ Southern Goldfields, 2nd ed., 1860, p. 128. § Australia as it is. II, 1852, p. 290. ‖ The Australian Colonies, 1852–3, p. 205. ¶ Goldfields and Mineral Districts of Victoria, 1869, p. 412. ** According to W. F. Petterd (Cat. Min. of Tasmania, 1893, p. 21), this sample was obtained on elevated land below the Tier, St. Paul's Plains. †† Proc. Roy. Soc. V.D. Land, 1854, II, pt. 3, pp. 424–5.

1853. New South Wales.

The Rev. W. B. Clarke, in Report No. VIII, dated Tarahmbwoan, Ranger's Valley, Severn River, 7th May, 1853, gives the first notice of the occurrence of tin in the New England district, which subsequently became noted for its stanniferous deposits. Writing of the granites of that region, he stated :—

> "Of metals besides gold, I have met with sulphuret of antimony as near Mount Mitchell (Oban.—J.E.C.) and in the Booroolong Run (as well as in the neighbourhood of Gara); graphite in radiating masses occurs in the granite east of Dundee, and in more plentiful quantity near New Valley; wolfram and oxyde of tin, with tourmaline, occur near Dundee (probably Hogue's Creek.—J.E.C.) and in Paradise Creek (a tributary of the Macintyre.—J.E.C.), and it is probable that this ore of tin is plentifully distributed in the alluvia of other tracts, as I have found it amidst the spinelle rubies, oriental emeralds, sapphires, and other gems of the detritus from granite. Iron also occurs in various modes in the veins traversing granite; and I am informed that both copper and lead have been detected in granite along the Peel."*

C. St. Julian and E. K. Silvester in 1853 alluded to frequent rumours of discovery of tin-mines in New South Wales and South Australia, but regarded them as unjustified.†

R. M. Martin in the same year mentions platina and tin having been found in small quantities in New South Wales.‡

1854. Victoria.

F. H. Storer, Chemist and Geologist to the United States Exploring Expedition to China Seas, &c., reported to Commander C. Ringgold, "U.S. Ship Vincennes," Port Jackson, 24th January, 1854, on tin ore in the gold drifts at the Ovens :—

> "Sir,
>
> "I have the honor to inform you that I have analysed several specimens of sand and small water-worn pebbles from the locality known as the "Ovens," which are found, owing to their great specific weight, mixed with the gold at the bottom of the miners' washing apparatus. They came into my possession through the kindness of Mr. F. Barrsfield, of Sydney, having been collected by that gentleman at the above-mentioned locality.
>
> "I find them to consist entirely of a very rich ore of tin, similar to the 'stream tin' of Cornwall, which yields from 50 to 70 per cent. of pure metal. Not only the black sand of the deposit, but also the yellowish and grey particles—some of them nearly transparent—which occur in it, yield unmistakable evidence of tin. Believing that these facts are not universally known, even if heretofore noticed, and deeming their promulgation may, by calling attention to the subject, lead to investigation concerning the quantity, localities, and practicability of working this valuable ore, I consider it my duty to mention the results of my examination to you.
>
> "I am, Sir,
> "Very respectfully,
> "Your obedient Servant,
> "(Signed) F. H. Storer."§

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* Gold Discovery Papers, II, pp. 344, 345. † The Productions, Industries, and Resources of New South Wales (Sydney, 1853), pp. 146-7. ‡ Australia, 1853, p. 472. § Clarke's Southern Goldfields, 2nd ed., 1860, p. 129.

The Rev. W. B. Clarke, in a letter to the *Sydney Morning Herald* of the 13th January, 1854, *re* discovery of tin ore at the Ovens, wrote :—

> "I found it abundantly in the Bendoc and other districts of the Southern country and about the Rocky River, and all through New England and its flanks. The first notice in the Colony, or in Australia, will be found in a paper on Mining which I contributed to your columns on the 16th August, 1849, now more than four years ago." †

Mr. Birkmyre, Manager of the Port Phillip Gold Company, in a letter to the Melbourne *Argus* of 2nd December, 1853, dealing with the mineral resources of Australia, irrespective of gold, wrote :—

> "Although the gold dust of the McIvor diggings occasionally contains tin ore—at least, I have found it twice or thrice—yet there is also a black sand which is apt to be mistaken for peroxide of tin; this substance does not contain a particle of tin, it being the oxide of a much rarer metal, viz., titanium. But tin ore in Australia seems to be greatly disseminated; for I find it to be present with the gold dust of the Echunga diggings, in South Australia; and, what is more remarkable, the gold dust of that quarter also contains carbonate of lime, being quite different from the ferruginous and siliceous matter of the Ovens Goldfield. ‡

A letter,§ dated Melbourne, May 28, 1854, from Samuel Bowden, Agent for the Ovens Mining Company, reports that leases for tin-mining could not be obtained, the Government regarding them as a monopoly and an interference with the gold-diggers. Reference was also made to tin ore from that field being purchased from the diggers at from £25 to £30 per ton, and being shipped to London.

1854. New South Wales.

Stream tin was exhibited by the Rev. W. B. Clarke, from "Reedy Creek" (probably Querra, or Reedy Creek, a tributary of the Macintyre, or Reedy Creek, near Warialda, where tin occurs at Gragin); and from "Summerhill," by S. Samuel. Tin was subsequently worked at Summerhill Creek, near Tingha; but as it was not discovered in this locality until 1872, it is most probable that the entry refers to Summerhill, near Rockley (though tin has never been discovered there), from whence the exhibitor's other samples (copper) came.‖

In 1854 the Rev. W. B. Clarke also recorded the presence of tin ore in the watershed of the Bogan River, in the following terms :—

> "He examined the detritus of the basin of the Upper Bogan River, and finds that it is rich in the peculiar minerals which distinguish the known goldfields; and amongst them he found gold, as well as tin and magnetic iron."¶

He also recorded the occurrence of tin in the country about Mitchell and the Rocky River, New England, associated with gold, garnets, and sapphires.** Mount Mitchell is on the north bank of the Sara or Mitchell River, not far from Oban, where tin was first worked in 1871. There are several Rocky Rivers, but the one most in evidence at that date (owing to gold discovery)

† Southern Goldfields, 2nd ed., 1860, p. 128. ‡ Mining Journal, 1854, XXIV., p. 113. § Mining Journal, 1854, XXIX, p. 832. ‖ Catalogue of the Natural and Industrial Products of New South Wales, exhibited in the Australian Museum by the Paris Exhibition Commissioners, Sydney, November, 1854, pp. 54, 56. ¶ *Op. cit.*, p. 61. ** *Op. cit.*

was the stream on which Uralla is situated, in which black sand was very abundant. A sample of the latter, recently assayed, yielded 0·35 per cent. of metallic tin, equal to about 0·5 per cent. of tin oxide.

1855. New South Wales.

The Rev. W. B. Clarke stated that in 1855 he received from Tumbarumba, amongst gems and other rejectamenta of the cradle, some small particles of oxide of tin.* These were doubtless from Burra Creek, near Tumbarumba, where for a number of years an appreciable quantity of tin ore has been obtained in gold-sluicing operations.

1855. Victoria.

Evan Hopkins, in 1855, wrote† :—

"Sir,

In reply to the inquiries of your correspondents regarding the tin ore of Victoria, I beg to inform them that the tin ore hitherto came from the residue of the gold workings at the Ovens.

"This tin ore is the production of the stanniferous granite of the district, and is of the usual crystalline character and good quality of what is called stream tin. This tin ore, however, is somewhat confined to one or two creeks in the Ovens, and is not found in all the gold washings. A very large proportion of the black residue of the goldfields is titaniferous and ferruginous sand. The specimens of granite I received from Western Australia, containing schorl and tourmaline, indicated that that Colony also must contain tin."

1856. Victoria.

Mr. George Foord,‡ who is credited as the discoverer of tin in Victoria, in a letter to Messrs. Clarke, gold-brokers, Melbourne, communicated some particulars of an important mineral discovery which had been made at Taradale, near Castlemaine :—

" The mineral associated with the Taradale gold-dust is stream tin. It differs in aspect from that of the Ovens district in being less water-worn ; in many of the pieces the crystalline form is distinct, and some of the facets retain a high reflective brilliancy. It may be observed that the site is in proximity to the granite."

1860. New South Wales.

Professor T. W. E. David states :—

" In 1860, however, a considerable quantity of stream tin, obtained from the alluvials of Oban, in the same district, was purchased as such by Lassetter & Co."§

Mr. Warden Graham also alludes to Oban being the site where tin was first found.‖

From investigation it appears that the Professor—who was then new to the State—was probably misinformed. Reference to Mr. F. Lassetter, sen.,

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* Southern Goldfields, 1860, p. 109. † Mining Journal, 1855, XXV, p. 68. ‡ Mining Journal, 1856, XXVI, p. 733. § Geology of the Vegetable Creek Tin-mining Field, Geol. Surv. N.S. Wales, 1887, p. 2.
‖ Ann. Rept. Dept. Mines, 1877, p. 109.

elicited the reply that the firm's books of that date were long since destroyed, and that he had no personal recollection of the matter. It was, however, the practice of the firm to buy ores for shipment to London.

Reference to the Collector of Customs established the fact that no tin, or tin ore, was shipped abroad prior to 1872. Certainly none was smelted locally for consumption.

It is, moreover, made abundantly clear in later references to tin at Oban—herein given—that tin ore was not publicly identified as such at Oban until November, 1871, after announcement of the discovery of payable tin at Elsmore, near Inverell; though the Rev. W. B. Clarke was aware of its occurrence in the vicinity (see page 10).

1861. New South Wales.

In the catalogue of the Natural and Industrial Products of New South Wales, exhibited at the School of Arts, by the International Exhibition (London) Commissioners, Sydney, October, 1861, p. 33, J. S. Norrie has an entry of three boxes of tin ore, but neither quantity nor locality are given therein, nor in the Press notices of the display.

1861. Western Australia.

F. T. Gregory, in a paper read 22nd May, 1861, recorded the occurrence of tin ore in Western Australia :—

> " The gneiss appears once more to the northward in a detached mass, extending from Champion Bay to the Murchison River, forming the fertile and rich mineral district, in which so many valuable lodes of lead and copper have been discovered . . . . . .
>
> " The gneiss here abounds in garnets, of rich colour, but much flawed; specimens of plumbago, tin ore, antimony, and arsenic are occasionally found. Specks of gold have also been obtained by washing the sands in the Bowes River."*

It may be here added that E. T. Hardman, in 1883, reported the occurrence of " quantities of minute dark heavy grains, which have all the appearance of stream tin, in the Fitzroy River gravels of the Kimberley district.†

In a subsequent report he states that the black sand was mainly magnetite, with ilmenite, and trifling traces of tin.‡

The discovery of tin in commercial quantities at Greenbushes is attributed to the same authority. A. Gibb Maitland, Government Geologist, states :—

> " The discovery of tin at Greenbushes would seem to have been due to the researches of the late Mr. E. T. Hardman, a former Government Geologist. This gentleman, while engaged upon official duties in the Blackwood district (in 1884.—J.E.C.), was accompanied by a Mr. Stinton, to whom Mr. Hardman suggested the probable occurrence of tin-bearing deposits. Having this in mind, Mr. Stinton, at the conclusion of the journey, returned to Greenbushes, and after a time eventually discovered the rich stream deposits worked by a Bunbury syndicate."§

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* Quart. Journ. Geol. Soc., 1861, p. 478. † Rept. on the Kimberley District, N.W. Australia, by J. Forest, C.M.G., 1883, Appendix D, p. 20. ‡ Rept. on Geol. of Kimberley District, by Authority, 1884, p. 22 § Geol. Survey, West Australia, Bulletin No. 4, 1900, p. 85.

1863. Victoria.

According to the Mining Journal, tin and antimony were shipped from Victoria in 1863.*

1863. South Australia.

Discovery of tin ore in South Australia was further reported; no particulars are given, but indications had been met with in several localities.†

1866. New South Wales.

In 1866 four bags of stream tin ore were tested at the Sydney Mint, and part of the metallic contents extracted.

The following letter explains the transaction:—

"Sir, Royal Mint, 28th August, 1866.

"I have the honor to transmit the enclosed report on the four bags of black sand left at the Mint by Mr. E. S. Hill, which have been assayed for tin, and a portion of the tin extracted, for the purposes of the Commissioners of the Paris Exhibition; in accordance with the wishes you were pleased to express on the subject.

"I also beg to forward the four samples of tin and the remaining portions of the black sand.

"I have the honor to be,

"Your obedient servant,

"(Signed) C. Elouis.

"The Honorable the Colonial Secretary."

Subsequently these samples appeared as entries in the catalogue of the New South Wales exhibits to the Paris Exhibition, 1867, p. 22. Unfortunately in neither case has the locality been mentioned. But the fact that entry No. 257 comprised "stanniferous sand from Rocky River, exhibited by E. S. Hill," probably fixes the locality of the other exhibits in which he was interested.

252	Stream Tin,	No. 1—30·39 per cent. tin	Exhibited by J. de V. Lamb and A. Morris.
253	,,	No. 2—49·74 per cent. tin	
254	,,	No. 3—69·92 per cent. tin	Exhibited by E. S. Hill and J. Milson.
255	,,	No. 4—47·85 p n	
256	,,	Four bars of tin, numbers corresponding to above figures.	

References to the Royal Mint and to the Chief Secretary's Office failed to to discover any records.

It is extremely probable that these samples were from the State, though the locality is not given, for in the Rev. W. B. Clarke's notes on the exhibits, he points out that the "distinctive differences in material mineral wealth between Victoria and New South Wales are not altogether confined to gold or tin, which latter metal is well represented in the New South Wales Court"; thus inferring that the exhibits were of local origin. The poverty of the occurrence was doubtless the reason no effort was made to prove and develop it,‡ for, as will be seen, commercial tin-mining did not begin until 1871, and in a previously unknown locality.

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* 1863 XXXIII, p. 352. † *Ibid.*, 1863 XXXIII, p. 914. ‡ See p. 11.

1866–7–8. Victoria.

The Victorian tin production up to, and for, the years mentioned is given by Brough Smyth* as follows:—

	Tons	cwt.
Tin ore, previously up to 31st December, 1866—Black sand and tin ore	2,473	4
,, From 1st January to 31st December, 1867	177	10
Total	2,650	14
	lb.	
Tin, previously up to 31st December, 1866	8,160	
,, From 1st January to 31st December, 1867	4,256	
Total	12,416	
	Tons	cwt.
For 1868—Export—Black sand	220	7
,, ,, Tin	5	8

1868. New South Wales.

Mr. C. S. McGlew, in a petition respecting the discovery of tin,† states that:—

> "In the year 1868 a Cornish gentleman, of considerable experience in tin, brought to Sydney samples of rich tin ore found at Bungonia by Styles Brothers of that place; a private company was formed, and an experienced miner (Mr. Jenkins) and your petitioner went up and joined the Styles, and endeavoured to find payable tin country, but without success."

Mr. McGlew states that, not being satisfied, he returned to Bungonia accompanied by another experienced Cornishman, and re-prospected the district with no better success. Tin ore was found, but not in payable quantity; altogether about 150 lb. were obtained.

Confirmation of this discovery is afforded by Professor A. M. Thomson, B.Sc., in his "Notes on the country around Goulburn."‡

> "The district to the east of Bungonia is remarkable for the number of mineral species which it affords, viz., copper, pyrites, galena, blende, stream tin, gold, manganese—containing a very small percentage of cobalt and a still smaller of nickel. Molybdenite also occurs here, disseminated in small particles through quartzite, the original component grains of which are easily discernible. Arseniate of iron is also found here, associated with arsenical pyrites."

The recent discovery of *Stannite* (sulphide of tin) in the Tolwong Mine in the Shoalhaven River Valley, near the Bungonia Caves, adds to the interest of these references.

Professor Liversidge states that a vein of tinstone, 1 inch thick, was being worked near Bungonia in 1870.§

Mr. C. S. McGlew, in a letter to the Writer, dated 1st September, 1910, states:—

> "The vein of tinstone near Bungonia was found by myself on a spur in Long Gully, about 3 miles east of Bungonia. Though at that date, 1868, I took the vein for sandstone; it was, in fact, only a crack in the rock filled up slightly with fine crystal tin and kaolin. Since then I have frequently seen the same thing in other tin-fields.

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* Goldfields and Mineral Districts of Victoria, 1869, p. 13. † Ordered by the Legislative Assembly to be printed, 2nd June, 1874. ‡ Trans. R. Soc. N. S. Wales for 1869–70, pp. 69, 70. § Min. Prod. N. S. Wales, 1882, p. 102.

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L. A. Cotton.

Elsmore Hill, Macintyre River.

Site of the first commercial tin-mining in New South Wales (in 1871).

"Long Gully is a tributary of the Shoalhaven River. It was at the head of this gully I worked the alluvial tin on the side of a water-course. The tin ore was confined to one place in a bend of the waterway; none could be obtained above or below this bend. The tin ore was coarse and associated with a little flaky gold like bran. It was near by on a spur I found the so-called tin vein; it did not go down any distance—about 5 or 6 feet. I prospected the place well."

The site is now better known as "Tin Gully." From the official records of the Department, it appears that the first lease was applied for by M. Bayley in 1869, and surveyed 17th September, 1869, as M.L. 264. The adjoining portion, M.L. 41, was applied for by C. S. McGlew and F. Styles, 10th June, 1870, and surveyed 8th July, 1871.

These portions were afterwards covered by application 81/1, Goulburn, for tin, by James Armstrong—Portion 115, of 80 acres, parish Inverary, county Goulburn; afterwards Mineral Conditional Purchase 84/77, by the applicant. In September, 1910, a small vein of tin oxide was discovered by W. O'Neill a short distance north-easterly from the original find.

1870. New South Wales.

In a paper "On the Occurrence of the Diamond near Mudgee," by Norman Taylor and Professor A. M. Thomson, read before the Royal Society of New South Wales, on the 7th December, 1870, the presence of "wood tin" is recorded as occurring rarely in the older Pliocene diamantiferous wash, and "stream tin" in the newer Pliocene drift.*

Tin ores are mentioned by the Rev. W. B. Clarke as amongst the exhibits at the Intercolonial Exhibition of 1870, held in Sydney, but it is not clear whether from New South Wales or from Victoria.†

J. D. Lang stated that "in the year 1870 a discovery of extensive deposits of tin was made in the New England or north-western interior of the Colony."‡ It is, however, clear from later references, that this referred to the Elsmore discovery of 1871.

1871. New South Wales.

The *Sydney Morning Herald* of 12th July, 1871, records that:—

"A large deposit of tin ore, of extreme richness, has been found in the northern district, near Inverell. A bag of it has been received in Sydney, and some of the ore smelted by a rude process has yielded over 70 per cent. of tin, with a slight admixture of silver, and some traces of gold. The metal has been pronounced to be of the finest quality, and as it is said that there are immense quantities of ore where the other came from, it is hoped ere long tin will be added to the metalliferous exports of the Colony. A large extent of ground about the mine has been leased from the Government by Messrs. Brown, Austin, and Barron, who intend working it without the formation of a public company."

In a later issue, 9th August, 1871, it was announced that:—

"Mr. Barron, lessee of the Elsmore Tin Mines, near Inverell, is engaged opening out the ground leased (800 acres). The ore which is rather granular and of about the size of small swan-shot, is being collected for the present from the surface, and stowed in bags ready for carriage to Sydney, where it is to be tested."

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* Industrial Progress of New South Wales, 1870, pp. 575, 577. † *Op. cit.*, p. 87. ‡ Historical and Statistical Account of New South Wales, II, 1875, p. 71.

The same paper on 4th October, 1871, announced:—

> "We have recently been favoured with a sight of a quantity of tin ore recently received from the above mine (Elsmore J.E.C.). The sample in hand consists of some seven or eight tons of ore washed out from the surface stuff, and which will probably give a return of 60 per cent. of metal. Some which had been more carefully washed gave an assay by Mr. C. Watt, of 80* per cent. This mine is situated in the vicinity of the township of Inverell, on a range bordering the Macintyre River. The ore was first found by a shepherd employed in the district, and was at once recognised by him as tin. He collected several bags of it, and sold one of these to a commercial traveller, who brought it to Sydney about twelve months ago, and made the discovery known to Messrs. Barron and Austin."

The foregoing records effectually dispose of the reported accidental discovery of tin ore at Elsmore by Messrs. Fearby in 1872, whilst prospecting for gem stones on behalf of Mr. Cleghorn, of Uralla.†

The actual facts relating to the commercial discovery of payable tin ore in New South Wales have been briefly set out by Mr. C. S. McGlew in his petition to Parliament, and personally by verbal communication to the Writer.

Mr. McGlew's petition, and a subsequent communication to the Press, were incited by a petition to Parliament by James Daw, of 228 Kent-street, Sydney (ordered to be printed on 18th September, 1873), in which he claimed to have discovered tin on the Broadwater, a tributary of the Severn, in 1849. From the records, it is at least clear that the shepherd—Joseph Wills—was the unconscious discoverer of tin ore at Elsmore, and that Mr. C. S. McGlew, and his financial partners, were the actual means of the discovery being commercially located, and the tin-mining industry inaugurated in New South Wales.

Mr. McGlew's statement—which is confirmed by Mr. D. S. Anderson, formerly of Newstead Station, Mr. J. Kerr, of Elsmore, and other old residents, and by the published records—reads like a romance of mining. Early in 1871, after his unsuccessful search for payable tin at Bungonia, Mr. James Brown, agent (then of Hamilton-place, Sydney), showed him a sample of tin ore which he had received from a commercial traveller, who had obtained it from a shepherd in an Inverell hotel, this fact being the only information available. Mr. McGlew—whose Bungonia experience had whetted his interest—endeavoured unavailingly to interest others in the proposed search for the tin locality. Eventually Mr. Brown induced Messrs. Barron and Austin to finance the undertaking, Mr. McGlew agreeing to investigate.

Arriving at Murrurundi, the railway terminus at that time, he proceeded to Armidale, and found the principal hotel crowded owing to the local race-meeting. At night, at dinner, he led the conversation round to the mineral resources of New England, and gradually to the object of his search—tin. On describing the character of the ore, in response to an inquiry, a gentleman opposite—who strangely enough happened to be Mr. D. S. Anderson, of Newstead Station, which embraced the Elsmore‡ tin deposit, near Inverell, said a shepherd on their run, who was regarded as eccentric, had something like the mineral described.

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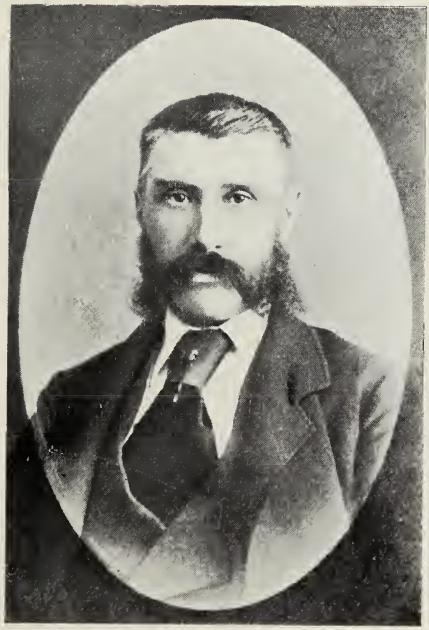
* An over estimate—78·34 being about the maximum limit. † Geol. Veg. Ck., 1887, pp. 2, 3.

‡ It might here be noted on the authority of Mr. J. H. Anderson, of South Newstead, that the original name was *Elmore*, after the first owner of the station on which it occurs.

PLATE II.



Mr. C. S. McGlew, who (in conjunction with Messrs. Brown, Barron, and Austin) was responsible for the initiation of the tin-mining industry in New South Wales, in 1871.

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Mr. McGlew, explaining privately the object of his quest, was offered transport to Newstead in the owner's conveyance. He, however, first visited Oban, where a miner named Clarke—afterwards an hotelkeeper there—had previously informed him of the occurrence of some heavy black sand in his gold workings, which greatly hampered operations.

Finding the mineral was mostly, if not all, ilmenite or titanic iron, he proceeded to Newstead Station, and found the shepherd—Wills—who showed him the black mineral similar to what he had sold the commercial traveller for a few shillings. Taking him to the spoil of an old saw-pit in Portion 50, Parish Anderson, County Gough, and to stools of fallen trees, at the site of the present Elsmore Sluicing Company's operations, he pointed out the heavy tin oxide exposed on the surface where the soil had been disturbed and subjected to rainfall. It may be remarked that the Elsmore tin ore is noted for the lustre of its crystal facets, many of which remain unabraded owing to the fact that the ore had not been transported from the site of the original matrix.

Mr. McGlew obtained a number of samples, sketched the locality, and returned to Sydney. Subsequently returning with Mr. Barron to Elsmore, between 25th June and 28th July, 1871, he washed out 6,396 lb. of clean tin ore in a small sluice-box fixed up at the Macintyre River, which constituted the parcel of ore referred to in the *Herald* of 4th October, 1871 (*op. cit.*) ; the first portion of land secured in fee-simple being Portion 2, Parish Anderson, County Gough.

From the official records at the Registrar-General's Office, it appears that this land was offered at auction at Inverell, on 6th July, 1861, but failed to bring the upset price. On the 30th September, 1871, Messrs. James Alexander Brown, Joseph Gerise Barron, and Solon Sinclair Austin, applied to be allowed to purchase it at the upset price (after auction sale), and it was alienated to them by Crown Grant, dated 29th February, 1872 ; no reservation of minerals being made in the grant. Mineral Conditional Purchases, 72–6468—6470, were applied for by Brown, Barron, and others, in October, 1872, and cover Portions 41 to 59 and 174, Parish Anderson, County Gough ; apparently they were previously taken up as ordinary leases in 1871.

Mr. D. S. Anderson, writing from England to the author on the 20th May, 1909, states :—

> "The facts stated in your letter (a copy of McGlew's statement.—J.E.C.) are all correct. I met McGlew in Armidale, and he came to Newstead and saw Wells or Wills (I am not really sure which was his right name), and then took up the Elsmore Tin Mine for Barron, Austin, and Brown. Wills then showed me some land down the creek on Newstead, on which we found surface tin, and I at once took it up for mining ; other blocks were taken up, and it was floated into a company by the late Sir Saul Samuel as the Newstead Tin-mining Company. I am sure that Wills did not know the mineral was tin until McGlew came. I cannot say how long he had the specimens in his possession, but he had often shown them to me before I met McGlew. Wells used always to be collecting bits of quartz and small sapphires, but I am sure that he had no knowledge of minerals. His great idea was that great finds of silver would be made some day on Newstead, that being the only metal I ever heard him mention."

Wills is buried in Newstead Churchyard, his headstone bears the following inscription :—

To
The Memory
of
JOSEPH WILLS,

Who departed this life 1st September, 1873,
Aged 65* years.

Here lieth poor Wills who found out tin,
But very little did he win ;
He paved the way for others' gains,
And died neglected for his pains.

This stone is erected to his Memory by a few friends.

James Daw, who claimed to have discovered tin ore in 1849 on the Broadwater, a tributary of the Severn River, then in the Colony of New South Wales, now in Queensland, in his petitions to Parliament as the discoverer of tin in New South Wales (printed 18th September, 1873, and 7th December, 1875), stated that :—

> " He submitted a specimen of his discovery to one John Scott, a metallurgist and silversmith, who declared it to be the best yielding tin he had ever seen ; also that after many years of labour he found it plenteously distributed in both the abovenamed Colonies."

In 1870 the petitioner claimed to have corresponded with G. Milner Stephen, Barrister, respecting his discoveries, and stated that from Bingara he forwarded some specimens of tin from Broadwater. He states that in 1871 he again returned to Inverell, and further corresponded with Mr. Stephen as to his discoveries.

In his second petition (7th December, 1875) he states that in January, 1871, he endeavoured to interest residents of Tenterfield ; also, in February, 1872, he further wrote to Mr. Stephen *re* tin, and to the Queensland Government, in March, on the same subject.

G. Milner Stephen, in a letter to Sir R. Murchison, dated Sydney, 5th October, 1871 (after announcement of the Elsmore discovery and the receipt of several tons of the ore in Sydney) communicated to the Geological Society, 20th December, 1871, apparently confirms Daw's statement as to correspondence, though his name is not mentioned. The above letter contains the following reference :—

> " No. 2 discovery is the *very recent one* of what I believe to be an enormous deposit of tin-ore in pepitas, crystals, and beds of conglomerate, and especially in micaceous granite, more or less decomposed. Small specimens I send you herewith by a Sydney merchant (Mr. Ed. Chapman) who proceeds ' overland ' from India, and can only burden him with a tiny parcel. I promise myself the gratification of sending to the Geological Society some large specimens by the first eligible opportunity." . . . "The centre of the deposit (which extends at least some miles) is about 29° 40′ S. lat. and 151° 20′ E. long., being in the district of New England, and about 15 miles from the township of Inverell, on the borders of the Macintyre. The country is granite, with whinstone. I had *long ago* heard from a correspondent of this tin deposit having been discovered by a shepherd, but did not believe it was of such prodigious value as I now know it to be."†

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* The figures are indistinct.—J.E.C. † Quart. Journ. Geol. Soc., 1872, XXVIII, pp. 42, 43.

In this reference the words italicised by the Writer are flatly contradictory, and opposed to Mr. D. Anderson's statement that the shepherd (J. Wills) referred to was unaware of the nature of the mineral he had collected until McGlew's arrival early in 1871.

In the discussion which followed the reading of the communication, D. Forbes stated that in 1859 he had placed in his hands some specimens of granite from the district the discovery of tin in which was announced by Mr. Stephen, and that he found them to be perfectly identical with the stanniferous granites of Cornwall, Spain, Portugal, Bolivia, Peru, and Malacca, which he had also examined.

If Daw knew of tin ore in the State as early as 1849, he apparently made no public stir in the matter for over twenty years, or until about the date of McGlew's location (in 1871) of Wills' discovery of payable tin at Elsmore.

Mrs. J. Kerr, of Sunny Side, near Elsmore, about one month subsequent to the latter, made a further discovery of tin ore close to the Macintyre, about 2 miles from the former; the second site being afterwards known as the "Karaula" Mine.

The actual public discovery, or identification, of tin ore at Oban followed soon after the announcement of a payable deposit at Elsmore, for in the *Sydney Morning Herald* of the 8th November, 1871 (or four months after the first press notice of the latter), the following appeared in reference to Oban :—

> "The following telegram has been forwarded to us by Mr. S. Blythe, of Armidale :—The Oban tin mines are creating great excitement in town and district. Upwards of 100 leases, I am informed, have been applied for. They differ from the Inverell mines in not requiring any expensive machinery to work them. The ore is stream tin, and in places very rich. Two men, I am assured, can knock out one ton per week with ease. It is pronounced by competent judges to be very rich, and the gold obtained in the claims will pay all working expenses. Captain Holman, representing Messrs. Fraser, Vickery, Zolner, and other wealthy Sydney people, is very active, and has taken up several hundred acres. A rush is anticipated. Oban is 40 miles north-east of Armidale. Gold diggers have been working there for years."

This notice disposes of the report that Lassetter and Company purchased quantities of tin ore from Oban in 1860.

On the 4th December, 1871, the *Sydney Morning Herald* quoted the Armidale *Telegraph* of the 25th November, as follows :—

> "The land for miles along the Mitchell River (near Oban.—J.E.C.) is taken up, but it is not expected operations will commence properly till the land is surveyed. Price of tin rising, Mr. Clarke giving £22 per ton."

The first tin leases in this locality were surveyed between 20th November and 6th December, 1871.

Tin ore was reported from Stanborough, near Cope's Creek, between Inverell and Bundarra (Tingha District.—J.E.C.), in the *Sydney Morning Herald* of 4th December, 1871.

In the issue for 26th February, 1872, tin ore was reported to have been brought from the tin-fields to Sydney, and to smelting works at Newcastle. The following companies were also announced as formed :—

Newstead Tin-mining Company,	1,000	acres,	capital	£60,000.
New Cornwall ,,	,,	280 ,,	,,	£30,000.
Belmore ,,	,,		,,	£10,000.
Sydney ,,	,,		,,	£60,000.
Mount Mitchell ,,	,,		,,	£75,000.

Professor David states* that tin was first discovered near the source of Vegetable Creek by Thomas Carlean in March, 1872. This site was afterwards secured by the Great Britain Tin-mining Company, and after yielding a phenomenal amount of stream tin in the early years of mining by the ordinary mining methods then in vogue, is now being remuneratively reworked by the modern method of nozzle-sluicing under steam pressure. G. H. Gower, Warden's Clerk, described the locality "where stream tin was first discovered in payable quantity in the district" as 4 miles east of Vegetable Creek—evidently at Tent Hill, on the opposite side of the watershed.†

Discovery of payable tin ore at Quart Pot Creek (now Stanthorpe, Queensland) followed shortly after the Elsmore discovery, Mr. C. S. McGlew again being chiefly instrumental in its announcement. A clue had been given him by Mr. G. W. F. Addison, Police Magistrate, whose interest, stimulated by the rich finds at Elsmore, revived recollection of a very weighty sandbag used as a wind-break at the Quart Pot Hotel, it was found that the source of the filling was the adjacent creek-bed.

Mr. McGlew and his partner, Mr. Eisenstaedter, acting on the presumption that the heavy sand might contain tin, at once proceeded to the locality, and immediately proved the correctness of the surmise; this being probably the first discovery in Queensland territory. The first report on Queensland Tin Discoveries (by T. F. Gregory) was read before the Geological Society, 6th November, 1872.‡

It is interesting to note that tin ore was discovered at Pulletop, near Wagga, and Jingellic, on the Murray River, near Tumbarumba, early in 1872, leases being surveyed at both places in that year.

Leases were also surveyed in the same year for tin mining on Thone Creek, parish of Walibree, county Macquarie, near Molong, on Boree Nyrang Station, and in the parish of Gowang, county Gowen: but no records of the discovery are available.

III.—ORIGIN AND NATURE OF TIN DEPOSITS.

Study of the literature of the "pneumatolytic" theory appears to justify R. Recknagel's warning criticism.§ As a provisional working hypothesis, it serves a useful purpose; but usefulness and value depreciate proportionately as the speculative nature of its premises is overlooked in postulating the genesis of tin deposits.

Moreover, there appears no logical reason for assuming a particular granite —in itself non-stanniferous—as the "ore-bringer" solely because of its closer constitutional approximation to the residuum, if it appeared as an intermediary product in a progressive magmatic process resulting finally in ore deposition.

It seems to the Writer more reasonable to regard the aplitic masses and pegmatitic dykes, and still more the siliceous solutions which intrude and invest several forms of granite and adjacent sedimentary rocks, indifferently, as the true "ore-bringers."

Broadly stated, it is unquestionable that tin deposits are usually associated with the above in areas of acid granite, which give rise to very sandy (quartz) soils and distinctive forestry, as in portions of the New England tin fields; but in some cases at least it is equally certain that contiguous more basic granites are similarly hosts of the stanniferous aplites, pipes, and quartz veins.

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* Geol. Veg. Ck., 1887, p. 3. † Ann. Rept. Dept. Mines for 1875, p. 108. ‡ Quart. Journ. Geol. Soc., xxix, 1872, pp. 1-5. § Trans. Geol. Soc. S. Africa, XII, 1910, pp. 168-202.

Hence, even if the "acid" granite approaches more closely the chemical composition of the assumed residual magmatic matrix of the tin ore than one less acidic, it is unreasonable to designate the former "stanniferous" and the latter not, if neither, according to the pneumatolytic theory, actually conveyed tin ore from the parent magma.

From Harker's illuminating statement* it is clear that pneumatolytic action, in its theoretic interpretation, relegates tin deposition to a final stage after consolidation of previously extruded material. Therefore consolidated granite extravasations, subsequently invested by pneumatolytic agents carrying tin or other metallic ores into joints and stress fissures of their mass, cannot of themselves be correctly regarded as the "ore-bringers" or "ore producers."

Harker's definition emphasises this point :—

> "Nevertheless it is clearly bound up with igneous intrusion, and must be regarded as belonging to igneous action. The pneumatolytic agents themselves are merely the final residuum of a rock magma, and the processes are conducted at temperatures more or less elevated, though progressively declining.
>
> "Pneumatolytic action in plutonic rocks is not confined to their pegmatoid modifications. In many cases it clearly follows joint fissures in the body of the rock, a sufficient proof that it belongs to a stage posterior to the completion of consolidation (*op. cit.*)."

Practically all writers on the subject agree in deferring ore entries until after consolidation of the granite massifs ; though E. C. Andrews, B.A., Geological Surveyor, appears to favour a more or less synchronous separation of the most acid constituents along peripheries during the closing phase of consolidation.

The granites of the New England district of this State—which contain the principal tin deposits—have been studied by the above, who has published several papers dealing with their modes of occurrence and relationship. His views of the latter in connection with the genesis of the tin deposits are embraced in the following brief extracts. After postulating that—

> "Into the late *Palæozoic* strata a number of granitic rocks were thrust, the earlier ones being basic varieties, the younger members being of much more acid types,"

Mr. Andrews goes on to state that—

> "The consolidating phases of these intrusions were attended by developments round their margins of pegmatites, eurite bosses, eurite and micrographic dykes, greisens, quartz reefs, and 'blows.' In all of these, great variability in composition and texture is evidenced. These acid secretions of the granites belong to various ages of intrusion. Many of the younger groups contain notable percentages of tin, wolfram, molybdenite, bismuth, monazite, and allied minerals."†

Of the younger members of the intrusive granites first mentioned, he states :—

> "A still later phase is an anastomosing series of fine-grained (eurites) whitish, greyish, or reddish granites, of very acid types. They may aptly be described as octopus-like occurrences, showing moderately large bosses ($\frac{1}{2}$ to 4 miles diameter), from which whole networks of similar dykes stretch into the older masses."

---

* Natural History of Igneous Rocks, 1909, p. 300. † Records Geol. Survey N. S. Wales, VIII, pt. I, 1905, p. 110.

"With these acid granites of coarse and fine grain, a whole series of *greisen* masses, eurite (at times miarolitic) dykes, pegmatite veins, quartz 'blows' and veins are associated, having a peripheral disposition with respect to the parent massifs."

"In the coarse granites themselves are segregations of tin, wolfram, and felspar, also of molybdenite and quartz, while in the later *greisens*, pegmatites, dykes, and quartzose veins with high values of tin, bismuth, tungsten, molybdenum (with, at times, gold and silver) are found."*

Mr. Andrews describes—

"A notable fact in connection with the gradually increasing acidity of type is the association of highly siliceous differentiations with certain of the later massifs. They are not confined to one age or phase of intrusion, *e.g.*, they are associated with the consolidating stages of the sphene-granite-porphyry, as well as with the coarse acid later types of granite. They occur near the planes of contact of the igneous masses with the invaded rocks. They comprise numerous greisens, pegmatites, micro-pegmatites, eurites, quartz-felspar masses, shading off into quartz veins and quartz 'blows'."

"In a word, an acid series of secretions accompanies a basic granite, then coarse granite magmas succeeding these, of less basicity than the sphene-granite, but more basic than the marginal excretions of the younger massifs.

"Similarly the greisens, pegmatites, quartz veins, &c., associated with certain of those later acid masses, evidence still later and more aqueous excretions from the massifs, around which they are grouped marginally.

"Only, however, in the later series of siliceous excretions do any *commercially valuable* mineral deposits occur."†

In a later work it is stated that these latest products of differentiation all "fall into one period, inasmuch as they intrude the coarse acid granites, and are, in turn, intruded by the rhyolite and quartz-porphyry dykes."‡

With the order of the entry, and association of the tin and other minerals in the tin-fields of New England here outlined, the present Writer is in complete agreement with Mr. Andrews, but the very general character of his views and their application over areas which have not been geologically mapped, have led to considerable confusion.

The following reference to the Tingha Tin-field conveys a wrong impression of one granite massif being intruded by the later euritic dykes, bosses, &c., whereas there are two marked types—the "Tingha"§ and the "Acid" (Andrews)—that have been invaded by the later aplitic or euritic dykes, &c.

"The country rock is a dark granite, containing abundant biotite and hornblende, and it is strongly porphyritic with large white felspars. It intrudes strata of late Palæozoic age. Although connected indirectly with the tin-bearing igneous rock, it does not of itself contain tin values. A series of large later euritic intrusions determined the ore entries. The eurites were accompanied by, and in many places show, gradations into pegmatites, colloid, and massive brittle quartz. With these pegmatites and quartz masses, topaz, rutilated quartz, and other minerals occur. Seritization of the eurites is common where ore deposits occur; and the general field observations indicate that, although the mineral deposits

* *Op. cit.*, p. 117. † *Op. cit.*, p. 119. ‡ *Op. cit.*, 1907, pt. 3, p. 221. § L. A. Cotton, The Tin Deposits of New England, Proc. Linn. Soc. N. S. Wales, 1909, XXXIV, p. 780.

are entirely dependent upon the eurites, nevertheless, in mass, they appeared not until the main eurite intrusion had taken place, but came up with the quickly following hydrated excretion of the eurites, and altered the latter in places to quartz and sericite. Eurites, with associated quartz, chalcedony, and pegmatite, containing payable tin deposits, also occur, the various rock members insensibly grading the one into the other."*

This reference does not include the other normal type of granite—the "Acid"—which predominates in the district, unless it has been defined as "eurite"; though in the geological map of the district now issued, the latter was found to be limited to dykes and irregular intrusive bosses in both the "Tingha" and "Acid" types.

The "Tingha" is described by L. A. Cotton as "characteristically a porphyritic granite, the phenocrysts being felspars and quartz. The felspars are chiefly plagioclases, and may be seen rather more than an inch in length, though typically they form almost square crystals, about half an inch in length. A considerable amount of biotite, and an almost equal amount of hornblende, are present. Apatite is an accessory mineral. The quartz grains are seldom larger than a pea, and are less numerous than the felspar phenocrysts. The ground mass consists of a second generation of felspar and quartz. The felspar phenocrysts cause the rock to present a striking appearance on weathering. It is remarkable that the felspars, usually so prone to decomposition, stand out in bold relief, often projecting a quarter of an inch or more above the surface of the rock. This is due, no doubt, to the more rapid weathering of the second generation of felspars, causing the rock to disintegrate round the phenocrysts." †

An analysis of a typical sample of this rock from Tingha will be found on p. 64, as well as G. W. Card's petrological description.

A typical sample of the "Acid" granite was selected from near Stannifer by E. C. Andrews and the Writer, an analysis of which will be found on p. 63. Mr. Card describes this rock as "a medium to coarse grained acid granite. Orthoclase is the predominant mineral, and gives to the granite a prevailing pink colour. A lesser amount of white felspar is also present. A little biotite and patches of a yellowish product occasion a speckled appearance," the silica contents of the latter being 76·28 to 71·27 in the "Tingha."

Mr. Cotton states that the

> "Tin-ore deposits have been found always closely associated with the 'acid granite,' though post-dating the solidification of that rock." ‡

If post-dating the granite in which they occur, then the granite cannot be said to have introduced them.

The Writer recently had the advantage of discussing with Mr. Andrews in the field the mode and order of occurrence of the two normal granite types in the Tingha district, and mutually agreed that the "Tingha" was first extruded, and after consolidation was itself intruded by the "Acid"; and, later still, both were indifferently intruded by the latest emissions—the aplitic, or euritic, and quartzose—which appear as dykes, bosses, and quartz veins carrying tin ore, &c.

At this point views diverged, as neither of the granites admittedly of themselves produced tin ore from the magma, the Writer was unable to admit the claim of the "Acid" to be considered as "stanniferous," to the exclusion of

* E. C. Andrews, Records Geol. Survey N. S. Wales, 1907, VIII, pt. 3, p. 239.
† Proc. Linn. Soc. N. S. Wales, 1909, XXXIV, pt. 4, p. 743. ‡ *Op. cit.*, p. 780.

the Tingha, simply on the ground of greater acidity, or nearer approach constitutionally to the stanniferous dykes and veins which intruded it after consolidation.

Unless field and petrological evidence is at fault, the extensive "Acid granite" massif of the Tingha district must be regarded as distinct from the later aplitic (euritic) and allied intrusions which have already—and it is considered correctly—been described by Mr. Andrews as the true "ore-bringers."*

Viewed in an economic sense, it is, perhaps, unwise to attempt theoretic distinctions in a mining publication that may lead to misapprehension and confusion, for it is to the granite rock or country itself, and not the incomparably lesser included dykes and vein-fillings, that the miner applies the term "tin-bearing." Hence the "Tingha" granite—seamed with tin veins, perforated by tin "pipes," and intersected by tin-bearing aplitic dykes—should not be designated non-stanniferous any more than the "Acid" should be strictly called stanniferous.

If a distinct line of demarcation were possible between stanniferous and non-stanniferous granites in a locality where basalt flows, decomposition and waste shroud so large a proportion of the area, and the distinction could be rendered plain to ordinary prospectors and miners, this would undoubtedly prove a valuable economic factor. But beyond indicating the fact—first rendered apparent by the operations of miners—that tin districts are usually characterised by acid granites and very sandy soils, no demonstrable division can be drawn that would guide the ordinary seeker. In fact, it is extremely doubtful whether any boundaries mapped can be other than empirical, for tin deposits, as is well known, are not confined to granitic rocks, but penetrate considerable distances into other formations adjacent to contacts.

From a study of a large number of stanniferous quartz veins, and aplitic tin lodes and pipes, the Writer strongly favours, in some cases, deposition from solution at temperatures much below that demanded by the pneumatolytic theory, frequently accompanied by ores of copper, lead, zinc, arsenic, iron, &c.

It is sometimes difficult to reconcile conditions existing in thin stanniferous quartz veins, or even in the larger ones, in sedimentary rocks at some distance from the granite contact, with the high temperatures indicated by the term *pneumatolytic*. It can hardly be accepted that the quartz and metalliferous ores were actually introduced in a gaseous condition. If in a molten state, it is questionable whether such extremely thin sheets of viscous matter could have been forced into the intruded rocks without chilling, considerable local heat being essential for such penetration beyond the contract.

Moreover, as C. Reid and J. S. Flett point out:—

> "It is noticeable that the cracks into which granite veins are injected seem never to contain metallic ores, nor do the fissures containing elvan dykes. Ores are found in fissures formed after the granite had solidified; and after cracks could remain open to great depths in the still hot mass.†

It is true that the term "solution" is frequently used in discussions of pneumatolysis; though scientifically correct, the commonly accepted meanings of the terms are antagonistic. Some writers, moreover, define it as "aqueous," hence further confusion.

If it be conceded that the final residuum of a magma be an actual aqueous solution below 360° C., then the original idea of deposition is reached.

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* Mr. Andrews on later examination confirms the presence of the two types of granite. † Geology of the Lands End District. Memoirs Geol. Surv. England and Wales, 1907, p. 58.

In the flow from a modern blast furnace in pyrite smelting, cuprous and ferrous sulphide—as matte—may possibly be regarded as temporarily dissolved or "held in solution" in the slag on its way to the fore-hearths, but here the comparison ends; subsequent separation depending almost—if not solely, on gravity. In pneumatolysis, diminishing temperature and consequent pressure alone determine deposition.

At the Mt. Lyell pyrite furnaces the flow passes through four fore-hearths before the slag is granulated and discarded. Mr. R. C. Sticht suggested to the Writer—during a recent visit to those instructive works—that the gradual fall in temperature—about 50° between furnace and discharge—probably assists the liberation of the small percentage of retained matte.

Whilst venturing criticism of what, at best, must remain a purely speculative theory, its value as a provisional working hypothesis is by no means questioned. Nor is it contended that all quartz fillings are necessarily from solutions at moderate temperatures. The passage of pegmatitic dykes into masses of almost pure quartz is a common feature in many regions; but the associated segregations of felspar and mica are never far distant—an association not discernible in ordinary quartz veins carrying metalliferous ores.

J. F. Kemp, whilst contending that "quartz veins not visibly associated with pegmatites are open to the same interpretation, unless there is positive evidence to the contrary, states that on the other hand, pegmatites, although widely developed, are but rarely provided with metallic minerals in notable amounts, and the same is true of the quartz veins associated with them"* their absence being accounted for, in many regions of pegmatitic development, by their probable absence from the magma.

The Writer's views of the occurrence of tin lodes in New South Wales coincide generally with those expressed by D. A. MacAlister, concerning the lodes of Cornwall:—

> "It will be noticed that in all cases the lodes occur concentrated in districts connected with the granite masses or their metamorphic contact zones, but this position is generally further characterised by the presence of post-granitic dykes of quartz porphyry (Elvan), which, like the lodes, have directions similar to that of the cleavage of the sedimentary rocks which they traverse. As a whole, the ores appear to represent the final phase of plutonic activity in the region, the sequence of events being: (1) intrusion of the granite masses with thermal metamorphism of the slates surrounding them; (2) intrusion of Elvans; (3) formation of tin and copper lodes accompanied by extensive mineralization of both sedimentary and igneous rocks.
>
> "The tin and copper lodes as a whole may be described as fissures of varying size and form, which contain a variety of ores of tin, copper, and other metalliferous minerals, together with characteristic veinstone accompaniments.
>
> "The structure of the lodes indicate to some extent their mode of origin; and while some of them are mere joints or cracks of the thickness of a knife-blade, others are of great width and contain much fragmental crushed material, indicating that they are probably of the nature of faults.

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* The Rôle of the Igneous Rocks in the formation of Veins. (In Genesis of Ore Deposits. Am. Inst. Mining Eng.), 2nd ed., 1902, p. 694.

"The variety of structures which the veinstones may assume under such circumstances is fully represented in Cornwall, and as a whole may be classified into one or more of the following groups :—

(1) Fissure, or series of close parallel fissures filled with metalliferous and other minerals.

(2) Mineralization of the walls of the lodes by impregnation or metasomatic replacement.

(3) Mineralization of crushed rock or breccias contained in the lode."*

Modes of Occurrence of Tin Deposits.

Leaving out of consideration alluvial deposits, the mode of occurrence of which is obvious, tin ore occurs *in situ* in granite and adjacent contact rocks, usually occupying fissures, frequently penetrating the walls, and sometimes disseminated in the granitic host.

The forms which the ore-bodies take have been variously called lodes, reefs, veins, pipes, stockworks, &c. The first three are interchangeable, but as the original definition of a defined fissure-filling is "lode," it has been adopted in this work. Reef is chiefly an Australian term, originally applied—according to Geikie—to an outcrop standing above the surface. It is also used to define the rock walls confining an old buried channel or "deep lead."

"Shoot" is the ore-bearing portion, or portions, in a lode channel. David in describing those of the Vegetable Creek District, states :—

"The ore, in nearly all the veins of this district, shows a tendency to run in shoots inclined more or less steeply from the horizontal obliquely along the plane of the lode. The average length of the six largest shoots is 100 feet."

Summary of Tin Veins.†

"The following provisional classification, based on the foregoing observations, is proposed for the tin veins of the Vegetable Creek District :—

"I. *True veins*, comprising—1. Fissure veins; example, 'Ottery veins.' 2. Joint veins ; example, 'Cliff vein.' Both these subdivisions may be further differentiated according as the veins to which they apply are *right running* or *marginal*, the right running veins being those which conform to the principal system of cracks in the granite, while the strike of the marginal veins accord closely with that of the junction line of the claystone and granite.

"II. *Pipe veins*, 'impregnations' or 'carbonas'; example, 'Graney's vein.'

"III. *Stockworks*.—1. Formed by lateral secretion (?) from the surrounding rock ; example, Stockwork at 'Gap,' Emmaville. 2. Formed by ascension and infiltration ; example, Stockwork at 'Hall's Grampians.'

"These three classes cannot, in practice, be always separated from one another by a hard and fast line.

"Joint veins, with shoots of ore at intervals, graduate into pipe veins; a fissure vein, by a change of strike, becomes a joint vein, and both, if they pass into a hard quartzose granite, are liable to become split up into a stockwork composed of numerous thread-like veins.

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* Economic Geology, III, No. 5, 1908, p. 369. † Geol. Veg. Ck., 1887, pp. 144–148.

"In the Vegetable Creek, as in other mining districts, experience has proved that it does not pay to remove the whole of the veinstone, but only those parts of it in which the ore has become sufficiently concentrated to pay the cost of extraction. Any laws with regard to the occurrence of such parts should, therefore, be of paramount importance in an inquiry like the present.

"The ore, in nearly all the tin veins of this district, shows a tendency to run in shoots inclined more or less steeply from the horizontal obliquely along the plane of the lode. In fifteen cases this characteristic was very marked.

"The average length of the six largest shoots is 100 feet; average width of the six largest shoots, $1\frac{1}{2}$ feet; average depth of seven largest shoots, 6 feet; average dip, 26°; average horizontal distances between shoots, about 80 yards; vertical distances (observed only at Gulf Tin Mines), 50 to 90 feet. Eleven shoots were observed to dip north-easterly; two shoots were observed to dip south-westerly.

"Some idea of the size and richness of the shoots may be formed from the following description of eleven of these ore bodies:—

Length in feet.	Depth in feet.	Thickness in feet.	Angle of dip.	Direction of dip.	Yield in tons.
55	$4\frac{1}{2}$	$\frac{5}{6}$	20°	East.....	7
127	15	3	12°	East.....	229
.....	$1\frac{1}{2}$	$\frac{5}{6}$	.....	.....	.....
.....	3	1	.....	.....	.....
7	1	$\frac{1}{3}$	.....	.....	.....
30	4	$1\frac{1}{2}$	37°	Easterly	.....
.....	$\frac{3}{4}$	.....	.....	do	.....
.....	4	$\frac{3}{4}$	19°	.....	8
125	.....	.....	19°	South-westerly ...	.....
150	.....	$\frac{5}{6}$	45°	do ...	40 (?)
120	15	$\frac{3}{4}$	20°	North-easterly ...	.....

"In veins, in which the 'shoot' structure is less marked, the ore is either more or less disseminated through the mass of the veinstone, or occurs in 'floors,' occupying the position of former transverse cracks, which cross the vein at right angles to its dip. The ore usually favours the hanging wall.

"The following appear to have most influence on the metalliferous character of these veins:—

1. Country rock.
2. Bearing of the vein, and relation of its bearing to that of joints in the country rock.
3. Amount of dip.
4. Associated minerals.
5. Development of walls.

1. *Country Rock.*

76 veins are enclosed in granite.
8 „ „ quartz-porphyry and eurite.
3 „ „ porphyroid.
3 „ „ claystone.

Influence of Country Rock on the metalliferous character of Veins :—

"A fine-grained hard quartzose granite is unfavourable, causing the veins to be narrow, and in some cases to become split up into a number of thin seams, as in the 'Gulf' group of veins, and the stockwork at Battery Mountain.

"Fine-grained schorlaceous granite seems equally unfavourable, as evidenced by Macdonald's lodes on the Glen Creek, where veins of tinstone and tourmaline, from 1 inch to 2 inches wide, show no appreciable alteration in thickness in a vertical extent of 200 feet.

"Porphyritic granite, with large, well-formed white crystals of felspar, is also prejudicial, as in the neighbourhood of the Haystack Mountain, where the quartz veins, as a rule, are not tin-bearing.

"The most favourable granite appears to be that in the neighbourhood of the 'Dutchman' mines. The rock in that locality is moderately hard, and may be described as an open-grained ternary granite, containing rather large greenish crystals of felspar, not sharply defined at the edges, but merging gradually into a more finely crystalline mass of felspar, quartz, and mica. Patches and bands of more coarsely crystalline rock are intermixed with the more finely crystalline, and geodes of felspar are not uncommon.

"Eurite dykes intersecting the coarse granite are also favourable.

"If the country rock be quartz-porphyry or eurite, the fairly soft, strongly cleaved felspathic varieties, with a greenish tinge due to the presence of chlorite or hornblende, are more favourable than those which are hard, less cleaved, quartzose, and white.

2. *Bearing.*

"The average strike of fifty-four 'right running' tin veins in the Mole Tableland granite is 39° 15′ east of north and west of south, the range of strike being from 24° east of north and west of south to 20° north of east and south of west. The average strike of the richest veins is 35° east of north and west of south.

8 veins strike exactly 40° east of north and west of south.
7 „ „ 35° „ „

"Out of thirty veins observed, seven exactly conform to the principal lines of jointing in the surrounding granite, while twenty-three do not, but intersect the joints at an acute angle of about 5°.

3. *Amount of Dip.*

"The average dip of thirty-seven veins observed is 77°.

33 veins dip north-westerly.
10 „ south-easterly.
3 „ are vertical.

"Those veins or parts of veins most nearly approaching the vertical have so far proved the richest, as at the Ottery Mine, Butler's Reef, &c.

4. *Associated Minerals.*

"Out of seventy-seven veins in which tinstone has been proved to occur, nineteen consisted of quartz and tinstone only, eight of tinstone and felspar only.

"The relative frequency of occurrence and character of minerals, associated in the veins with tinstone, is given on the following table :—

69	veins	contain	quartz.
29	,,	,,	chlorite.
20	,,	,,	felspar.
8	,,	,,	mica.
8	,,	,,	mispickel.
4	,,	,,	iron pyrites.
4	,,	,,	fluor-spar.
3	,,	,,	tourmaline and schorl.
3	,,	,,	wolfram.
2	,,	,,	blende.
2	,,	,,	galena.
2	,,	,,	copper pyrites.
2	,,	,,	bismuth.
2	,,	,,	molybdenite.
2	,,	,,	vesuvianite.
2	,,	,,	stilbite.
1	,,	,,	hæmatite.
1	,,	,,	phyrrhotine.
1	,,	,,	manganese.
1	,,	,,	scheelite.
1	,,	,,	beryl.

5. *Development of Walls.*

"Well-defined walls were observed in fourteen cases, generally showing slickensides. The foot-wall is usually cleaner and better defined than the hanging-wall. The best veins in the district have good walls. Where walls are absent their place is taken by a central crack traversing the veins, the veinstuff on either side passing very gradually into granite.

"*Commercial Value of Tin Veins.*—Apart from considerations of cost of labour and carriage, two conditions which most directly affect the value of a vein are :—

1. Size of vein.
2. Proportion of ore contained in the vein to the veinstone.

"1. *Size*—(*a*) *Length.*—The greatest length for which a vein has been observed by me to be tin-bearing is 1 mile. This is Butler's vein. The Wallaroo vein will also, probably, be found to be tin-bearing for an equal length.

"(*b*) *Width.*—The average width of 69 veins is 1 foot $6\frac{3}{4}$ inches. The following are the thicknesses of six of the largest veins now being worked :—

1.	Ottery vein	3 feet.	
2.	,, ...	4	,,
	Butler's vein.....	3	,, 2 inches.
1.	Dutchman vein.....	4	,,
2.	,, ...	3	,,
	Curnow's vein	3	,,

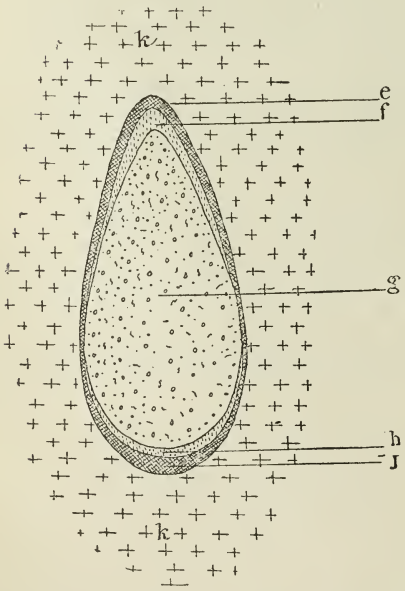
Tin Pipes.—E. C. Andrews describes generally the "pipes" of tin or bismuth which came under his observations as follows :—

"These are cylindrical masses of ore and gangue, which owe their origin to the action of heated mineralized waters (and gases) rising along joints. The 'pipes' were determined at the joint intersections.

"Generally at some little distance from the 'pipe' the granite country is seen to be slightly altered, the ferro-magnesian elements become clouded, while still closer towards the 'pipe' they may be replaced by chlorite or sericite. Similarly for the felspars. The centre portions of the pipe generally consist of solid, granular, glassy, brittle, or crystallised quartz, with slighter admixtures of sericite and tin, molybdenite, wolfram, bismuth, or gold; but they may consist of solid felspar, pegmatite, sericite, or greisen with ore deposits. In all may be seen the gradual change from these quartz, felspar, sericite, or other cores to the unaltered country. Moreover, they all belong to the *euritic* period of intrusion. A marvellous feature in this connection is the apparent insignificance, in width, of the determining joints with the volume of the country replaced by the heated waters rising at their points of intersection.*

The only other locality where similar tin "pipes" have been noted is South Africa. H. Kynaston and E. T. Mellor have described them at some length. Extracts from their descriptions are given for comparison with those of local occurrence :—

"The cassiterite-bearing pipes may be admirably studied in the Zaaiplaats workings. They may be described as roughly cylindrical bodies of altered granite carrying cassiterite and other associated minerals. They are roughly circular, oval, or elliptical, in transverse section, of varying dimensions, and descend at varying angles of inclination into the granite."



(*e*) Tourmaline rock, 6 inches.

(*f*) Cassiterite, 10 inches.

(*g*) Pipe-filling of highly altered granite containing 5 per cent. concentrates.

(*h*) Cassiterite, about 6 inches.

(*j*) Tourmaline rock.

(*k*) Granite.

Fig. 1.—Diagrammatic transverse section of a pipe-vein in the Groenfontein–Roodepoort Section. (After Kynaston and Mellor, p. 61.)

* Records Geol. Survey N. S. Wales, 1897. VIII, Pt. 3, p. 234.

. . . "It is a common experience in the mining of these deposits to find that neighbouring pipes, while quite distinct at the surface, will unite into one body at various depths. . . . On the other hand, it has sometimes been found that two neighbouring pipes, while behaving independently of each other in depth, may unite at or near the surface. There is also an interesting case on Zaaiplaats of two pipes intersecting one another in depth without either losing its individuality. A pipe will maintain, on the whole, a uniformity of dimensions and direction for a considerable distance, though there may be frequent irregularities, bulges, contractions, &c., and changes of direction along its course. . . . Generally speaking, the pipes are at first highly inclined, sometimes vertical, and then assume a more gentle angle of inclination, and are often approximately horizontal along part of their course. In some cases fissures are found connected with the pipes, and the mineralization then extends along the fissure. Throughout the greater part of their length, however, no genetic connection can be established between the pipes and any fissuring, faulting, or intrusions in the granite, and occasional association with such appears to be accidental. Lines of fissure in some cases may, to a certain extent, have affected the behaviour of the pipes, but do not appear to have any definite connection with their mode of origin.

"Two of the larger ore-bodies have been proved to a depth of over 400 feet on the incline, and show no marked change in any of their more important features. The diameter of the pipes varies from 2 to nearly 12 feet. The height in section is usually greater than the width. . . . They are usually well-defined and sharply marked off from the surrounding rock, the passage from the normal unaltered coarse granite to the highly altered body of the pipe being very rapid." . . .

The filling of one is described as consisting "essentially of either cassiterite and red felspar, the latter being an original constituent of the granite, or of cassiterite and secondary white quartz, indicating the complete replacement of the original rock.

"Cross sections of the tin-bearing pipes very commonly show a characteristic zonal arrangement, due to distribution of the successive phases or degrees of alteration of the granite, as produced by the mineralizing agents. The granite often becomes of a rather redder colour than usual within a few inches of the margin of the pipe, owing, no doubt, to incipient alteration of the felspars, and the red zone is sometimes succeeded by an aureole of tourmaline-quartz rock, forming a casing to the actual cassiterite-bearing portion of the pipe. In the majority of the Zaaiplaats pipes, however, the tourmaline border is entirely absent.

"Very commonly, especially in the richer ore-bodies, the pipe filling consists of a greenish substance, varying from a pale greyish green to almost black, and possessing a homogeneous appearance to the unaided eye. In the different pipes every gradation may be found between the highly altered phase, in which the original granite is no longer recognizable, and an apparently unaltered phase, in which the original quartz and felspar can be easily recognised."*

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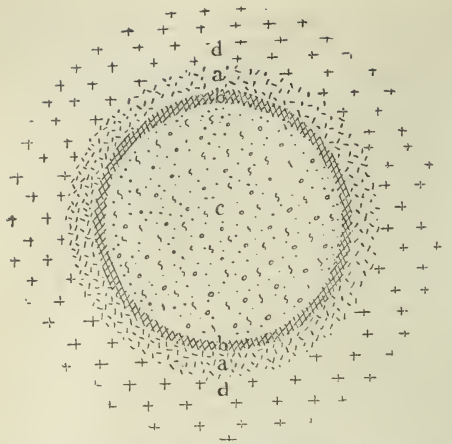
* Geol. Survey Transvaal, Memoir No. 4, 1909, pp. 50–52.



(*a*) Slightly altered granite with much red felspar.

(*b*) Zone of tourmaline rock.

(*c*) Altered granite with cassiterite, about 2 feet in diameter.

(*d*) Normal coarse red granite.

Fig. 2.—Diagrammatic section of small cassiterite pipe, occurring as a lateral off-shoot from a larger one. Zaaiplaats. (After Kynaston and Mellor, p. 52.)

The origin of the pipe form of ore deposit is not yet thoroughly understood; several views have been put forward. E. C. Andrews attributes the initiation of the pipe to the action of mineralised waters (and gases) rising along intersection of cross-jointings. The rarity of "pipes," however, where cross-jointing is common, is an unaccountable feature of this otherwise probable solution.

Kynaston and Mellor, on the other hand, are of opinion that there is no genetic connection between the Transvaal pipes and fissuring; their own views are stated in the following extract:—

> "So far, no satisfactory explanation has been advanced that can account for the formation of the pipes, their peculiar behaviour, and general apparent independence of lines of fissure. It seems not unreasonable, however, to suppose that they were in all probability formed in an originally deep-seated portion of the granite, which, although practically consolidated, was still doubtless at a very high temperature, and probably at that time had not undergone fissuring to any great extent. Relief of pressure, however, consequent upon the formation of fissures at higher levels, may have initiated the release from the underlying magma of the metalliferous compounds, which would then have ascended in gaseous condition through a practically unfissured zone."*

Clement Reid and J. S. Flett, in describing the mode of occurrence of tin lodes in Cornwall, state:—

> "As far as is known, all the ores are connected with joints or fissures of some sort, and the variety of forms the bodies of ore may assume is mainly dependent on the nature and form of the fissuring.†
>
> 'Carbonas,' which correspond with the Australian 'pipes' ('bungs' of the miner) are defined as nothing more than "exceptional developments of the features of ordinary lodes, and in all cases are associated with cracks or joints. They are pipe-like or irregularly-shaped bodies of tin ore, schorl, chlorite, and quartz, with other minerals, and owe their origin to alteration and mineralization of country rock (generally granite) in the neighbourhood of a vein."‡

* *Op. cit.*, p. 102. † Geology Lands End District, Memoirs Geol. Survey England and Wales, 1907, p. 96.
‡ *Op. cit.*, p. 96.

Permanence of Tin Lodes in Depth.

The majority of the individual ore-shoots in New South Wales tin lodes proved of very limited dimensions, and thus early led to want of faith in their permanence, even though the lode channel persisted. To this may be attributed the shallowness of mining development, and early abandonment. The greatest depth reached does not exceed 360 feet—and that in one instance only—even in permanent fissures like the Ottery, Butler, Dutchman, Walleroo, and other lodes.

In small lodes naturally it is an economic question soon solved, whether or no it will pay to persevere between the blanks, especially in hard country. But in more extensive channels there is every inducement to push on vigorously with development; indeed, it should be kept well ahead of stoping. Unfortunately, too often the reverse is the case in actual mining. Only when the visible ore supply fails are efforts made to see ahead; and after the proceeds of stoping have been absorbed, there is a natural disinclination to pay up for development which should have legitimately preceded surface outlay, and continued synchronously with winning.

Lodes of abnormal dimensions are very rare in all tin-producing countries; seldom more than one stands out conspicuously in each. It is chiefly to the aggregate yields of normal types, however, that the future must look for its requirements, though the former may continue to yield their quota until increasing depth and poverty exceed the possibilities of mechanical dressing efficiency and economic mining.

Though the majority of the tin lodes yet discovered in the local tin-fields are unquestionably on a small scale (sixty-nine in the Vegetable Creek District averaging $18\frac{3}{4}$ inches in width)* nevertheless their number is great, and there is direct evidence of the undiscovered or undeveloped being equally numerous. The granite massif forming the Mole Tableland is seamed with tin veins, as attested by the stanniferous burdens of the streams draining it, as well as the actual discoveries *in situ*.

Regarding the permanence or persistence in depth of the principal lines of fissuring—represented by lodes—David has published some geological evidence.

> "Far wider evidence, however, than that afforded by shafts is to be gathered from a comparison of the levels at which the veins are found to be tin-bearing at different points in close proximity, and from a rough estimate based on natural sections, of the vertical distance between the point where a vein commences to be tin-bearing and the point where it ceases to be so. The present surface of the granite, in which the tin veins occur, was not surface ground at the time of their formation. This statement may seem absurdly obvious, but in practice many mistakes arise from an imperfect comprehension of this simple fact. Many miners appeared to me to be under the impression that the veins had been formed in fissures at the present surface of the granite. In consequence, after sinking to a depth of about 100 feet, which is as far as most individual shoots extend vertically, and finding that the ore became nipped, they have abandoned the work in the belief that the ore could not have penetrated from the surface below this level. Hence the number of old shafts in the district in which sinking has been discontinued at depths generally not exceeding 100 feet. Where a good

* Geol. Veg. Ck., 1887, p. 148.

shoot of ore has been showing on the surface, work has been commenced and the shoot worked out; but seldom have attempts been made to win underlying shoots by continuing the sinking below the impoverished portions of the veins. The existence of such underlying shoots has been proved at the 'Gulf' and 'Ottery' mines (at the 'Butler' also.—J.E.C.). That the present surface of the Mole Tableland granite is mostly far lower than it was at the time when the tin veins were formed is proved—(1) by the coarsely crystalline structure of the granite, the formation of such a structure being possible only under great vertical pressure, such as would be produced by the superincumbent weight of several thousand feet of strata; (2) by the quantity of stream tin at the bottoms of the deeply eroded valleys of the Mole Tableland, attesting a vast amount of vein material removed by denudation. Where a valley intersects a tin vein, and the vein is found to be tin-bearing at the bottom of the valley as well as at a point on one of its sides, say, 200 feet above, the assumption is justifiable that the vein, if sunk upon at the high level, will prove to be tin-bearing downwards, at least as far as will bring it on a level with its lower tin-bearing outcrop at the bottom of the valley, *i.e.*, for 200 feet. Nature, by carving out that valley, has notched the reef to that depth, and so has practically prospected it. According to this method of calculation, the principal veins of the Mole Tableland, unless they have been greatly denuded, should continue to be tin-bearing for a vertical extent of at least 400 feet. The absolute distance to which individual veins will prove to be tin-bearing cannot, of course, be ascertained without actual experiment. The following facts, however, prove that there are certain upward and downward limits to the tin veins which can be roughly stated. On consulting the geological map accompanying this report, it will be noticed that the commencement of most of the veins is situated near the junction of the claystone with the intrusive granite, so the upward limit of the veins may be said to be the bottom of the claystone and top of the granite. The map also shows that as a rule the granite at a distance of over $1\frac{1}{4}$ miles from its junction line with the claystone ceases to be tin-bearing. The barrenness of the portions of the granite boss at a greater distance than this from the claystone appears to me to be due to the fact that these central portions have at one time been higher than the surrounding granite, and consequently have suffered more from the effects of denudation, so that the tin-veins which once over-arched these barren patches have been entirely swept away. The question now arises, to what extent has the granite been worn down at the points where it ceases to be tin-bearing. To ascertain this, it would be necessary to restore approximately the original surface of the granite, and, consequently, the surface of the veins over these points. Such a restored outline would, probably, take the form of a curve or succession of curves, and to calculate their amount roughly it would be necessary to discover the angle at which the granite emerges from the claystone. In Cornwall, England, deep mines in the killas near its junction with the granite, sunk through the former into the latter rock, show that the intrusive granites there dip under the killas at about 45″. A few observations, however, in the Vegetable Creek district led me to infer that the angle of dip, and consequently of emergence of the granite here does not exceed between 10° and 20°. At this rate the veins would die out between 1,000 and 2,000 feet. Great latitude, however, must be allowed in making such a calculation for the nature and size of the vein, as wide fissure veins would obviously extend far deeper

than narrow joint veins. The above statement applies only to those veins which dip away from the claystone into the granite, as is generally the case. A few veins, notably the 'Ottery,' dip towards the claystone. For the downward limit of such deposits I was unable to obtain any evidence, but they appeared to me to show more signs of permanence than veins of the former class. The underlie of the veins agrees with the dip of the sedimentary palæozoic rocks, but I was unable to discover why the shoots usually pitch to the north-east."*

The deepest tin-mine in Australia is the Vulcan, Irvinebank, North Queensland, now opened to the 1,400 feet level.

The deepest tin mine is the Dolcoath, in Cornwall, which during 150 years of its existence, according to S. Fawns,† has yielded minerals to the value of over £6,000,000, and is still the largest tin-producer in Cornwall. It was known as an ore-producing mine in 1746. In Cornwall tin lodes have remained payable down to over 3,000 feet. R. J. Frecheville, in 1887, gave the depth of the Dolcoath Mine as 485 fathoms (2,910 feet) following the underlay; and the length of continuous working along this great lode as about 2½ miles.‡ The new vertical shaft in the Dolcoath property had reached 2,832 feet at the end of 1909, and it was intended to continue to 3,000 feet;§ the output for the latter half of 1909 being 43·68 lb. of dressed ore per ton—equal to 1·95 per cent.

The depths reached in the principal New South Wales tin-mines are as follows:—

PRINCIPAL Depths attained in the Tin Lodes in New South Wales.

Name of Lode.	Feet.	Remarks.
Butler	360	
Stannum (or Bark Hut)	265	
Dutchman	215	
Jingellic	220	
New Cornwall	200	
Reeves'	200	
Victory (Euriowie)	200	
Wheal Byjerkerno	200	
Simoni's	183	
Whim Lode (Battery Mountain)	150	
Riecher's	135	
Block 30	135	
Caloola	135	
Planet	120	
Cricket Ground	106	
Chapman's	106	
Stiveley	100	
Coronation	100	
Rooney's	100	
Oliver's	98	
Federal	96	Shaft continued to 200 feet—not on the lode.
Binghye (or Binghi)	85	
Leviathan	80	

* Geol. Veg. Ck. 1887, pp 149 to 157.
‡ Trans. Roy. Geol. Soc. Cornwall, 1887.
† Tin Deposits of the World, 2nd ed., 1907, p. 194.
§ Eng. and Mining Journal, 12th March, 1910, p. 565.

Low Grade Deposits.—The commercial limit in a tin deposit of original or progressive poverty is entirely dependent on magnitude, location, and association. As an instance of extreme minimum the Altenberg deposits may be quoted. A. N. Winchell, in his description of these deposits, says :—

> "The cassiterite occurs in the zwitter [altered granite.—J.E.C.], as fine grains which are usually so small as to be invisible to the naked eye. The percentage of tin is extremely low, varying from 0·1 to 0·9 per cent., with an average of about 0·3 per cent. The bismuth content is about 0·002 per cent. It is only as a result of the peculiarly favourable conditions existing here [water-power, for instance.—J.E.C.] that it is possible to still work such low-grade ore."*

"Zwitter," regarded by von Cotta as merely an altered form of granite, which became impregnated with solutions of silica and tin, in combination with other elements, whilst at the same time it was subjected to influence of heat, and felspar removed in solution ; is described by A. G. Charleton as a—

> "Dark grey or greenish-coloured rock, frequently almost black, that holds one-third to one-half per cent. of tin, and is of remarkably fine texture, composed essentially of quartz with chlorite or lithia-mica and cassiterite ; specular iron, wolfram, mispickel, and traces of other metallic sulphides, in addition to several non-metallic minerals, being also sometimes found among its constituents."†

Another instance of extremely low-grade ore being worked is quoted by S. Fawns :—

> "In the Great Wheel Fortune Mine, Cornwall, a stockwork in killas associated with a lode has been worked. The principal excavation runs south-west, and is about 400 feet long by 50 feet wide and 60 feet deep. The average produce of the stuff stamped and treated is about 12 lb. to the ton "‡ [one-half per cent.—J.E.C.].

F. H. Bathurst states that at the Mt. Bischoff Mine, Tasmania, the—

> "Chief sources of ore supply are the White Face on the southern slope and the Don workings. Some of these are five benches in height. Rich seams of tin ore can be detected, but the whole mass is worked so as to give an average of about ½ per cent. of tin oxide, according to Mr. J. D. Millen, general manager."§

IV.—TIN : CHARACTERS, &c.

Tin (Sn.).

Atomic weight, 119 ; specific gravity (Schnabel and Louis) cast tin, 7·291 ; rolled tin, 7·299 ; electrically deposited, 7·143 to 7·178.

Melting point (different authorities), 228° to 232·7° C.

Boils at a white heat (between 1,600° and 1,800° C.), and burns with a white flame in the air at this temperature, forming stannic oxide (Schnabel and Louis).

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* Economic Geology, 1910, p. 171. † Tin Mining, Dressing, and Smelting, 1884, pp. 3, 4.
‡ Tin Deposits of the World, 1907. p. 15. § The Mining Magazine, 1910, III, No. 3, p. 198.

Conducting power for electricity at 21° C. is 11·45 (Mathiessen) or 14·01 (Becquerel), silver being taken as 100.

Physical Properties.

"Tin has an almost silvery whiteness, with a slight bluish tinge, and a brilliant lustre. The latter depends, to a large extent, on the temperature at which it is poured: if the temperature were too high, the surface would show iridescent colours, while if poured at too low a temperature the surface would be dull. The admixture of small quantities of foreign metals (lead, arsenic, antimony, iron, bismuth) also diminishes the lustre of tin.

"Tin is dimorphous. It crystallises in the forms of the tetragonal and rhombic systems. The tetragonal form is obtained by reduction from a solution of stannous chloride, or by cooling molten tin at the usual temperature of the air. Rhombic tin is produced by a very gradual cooling of molten tin at a temperature slightly lower than its melting point. The structure of tin is distinctly crystalline; if the surface of a tinned plate or tinfoil be etched with hydrochloric acid, which contains free chlorine, or with stannic chloride, it becomes covered with a pattern resembling frost pictures on windows (*moiré metallique*). A bar of tin emits, when bent, a characteristic creaking noise, the so-called 'cry' of tin. This is due to crystalline structure, the individual crystals grinding one against another on bending."

"Tin is harder than lead, but softer than gold. It is so extensible at ordinary temperatures that it can be beaten and rolled to thin leaf (sheet tin and tinfoil). At higher temperatures its extensibility diminishes, until at 200° C. it is so brittle that it breaks to pieces when hammered, and can be powdered. If the temperature at which tin is cast be either too high or too low, it will be 'short,' *i.e.*, brittle. The addition of 1 per cent. to 2 per cent. of copper or lead increases the hardness and tenacity of tin."

"Tin is ductile, but possesses little tenacity; it is most ductile at about the temperature of 100° C.; a wire of 0·08 inch in diameter breaks under a load of 54 lb."*

Mineral associates affecting quality of Tin (Schnabel and Louis).

"Tin is usually contaminated by iron, arsenic, antimony, lead, copper, bismuth, tungsten, molybdenum, and stannous oxide. The effect of these impurities are:—Iron, if present in considerable quantities, makes the tin hard and brittle; arsenic, antimony and bismuth, if present to the extent of 0·5 per cent. reduce its tenacity; copper and lead (1 per cent. to 2 per cent.) make it harder and increase its strength, but make it less malleable; tungsten and molybdenum render it less easily fusible; stannous oxide reduces its tenacity; sulphur is said to render it "short."†

A. G. Charleton states that iron in tin, even of the best quality, injures its colour and lustre more or less when it exceeds ½ per cent.; and 1 per cent. is sufficient to make it dark, short, *i.e.*, brittle and dull, besides causing rust spots to appear on its surface when exposed for a long time to the air. Copper in small quantity does no harm, but above 1 per cent. it makes the

* Schnabel and Louis, Handbook of Metallurgy, 1898, II, pp. 374. † *Op. cit.*

tin harder and less malleable, whilst a larger amount increases its brittleness deprives it of lustre, and, when it exceeds 11 per cent., trebles its hardness and gives it a perceptible tint. Its presence, however, is very desirable in metal used for making tinfoil for looking glasses, as it prevents the mercury attacking the foil too readily. Bismuth and antimony give it a crystalline structure, and, when over $\frac{1}{2}$ per cent. of either is present, injure its malleability, even more than iron; the former metal also renders it more fusible. Lead makes it harder, and imparts a greenish tint to it. Arsenic, even if there is only $\frac{1}{2}$ per cent., notably influences its malleability as well as its colour and lustre, and when it contains above 1 per cent. the tin becomes lighter, and is covered with white spots, making it in time dull, darker, dirtier-looking, and spotted.

Zinc renders it whiter, but harder and more brittle. Tungsten and molybdenum in large quantity similarly affect it.

English common tin contains $\frac{1}{5}$th per cent. of iron, and copper up to 1 per cent., but, when refined, any arsenic, lead, or copper that may have been present is removed, and the iron reduced to $\frac{1}{10}$th per cent.*

Removal of Impurities.

"The purification of tinstone from the greater part of its impurities is readily done by taking advantage of its high specific gravity, its stability at a red heat, and its insolubility in acids."

"In consequence of the high specific gravity of tin ore, it is possible to remove earths, quartz, silicates, as well as most of the metallic oxides, by mechanical treatment. The stability of tinstone at a red heat allows the hard siliceous pieces of ore stuff to be calcined previous to dressing until they are brittle, and by the oxidation which take places during the roasting, sulphur, antimony, and arsenic are driven off from their compounds in the ore. The insolubility of tin ore in acids permits the removal of bismuth and copper from the roasted ore by means of acids."†

Tin Alloys.—"Tin alloys with most metals in almost any proportion; of these alloys many, on account of their special properties, are applied in the arts. Among them must be mentioned the tin-copper alloys, *e.g.*, bronze, gun-metal, bell metal; the tin-lead alloys, *e.g.*, pewter, tin-foil, soft solder; the tin-antimony alloys (sometimes with the addition of lead and copper), *e.g.*, bearing-metal, britannia-metal; the tin-bismuth-lead alloys used for type, calico-printing blocks, and castings; the tin-zinc alloys used for imitation silver leaf; and tin amalgam used for silvering mirrors."‡

Commercial Salts of Tin.—Artificial stannic oxide, "Putty Powder," used for polishing, enamels, &c. Prepared by heating tin in air at temperatures above its melting point.

Chloride of tin with gold forms rich crimson and purple colours in glass staining.

Nitrate of tin used in dying. Tin-mordants. Bisulphide of tin—known as "Mosaic gold," bronze powder.

Native Tin.—F. A. Genth states:—

"In the washings from Aberfoyle River, about 15 miles from the town of Oban, New South Wales, native tin exists in the form of irregular, somewhat globular, grains, or aggregations of grains; they are distinctly

* Tin Mining, Dressing, and Smelting, 1884, pp. 41-2. (*See also* under "Smelting") † Handbook of Metallurgy, 1898, II, 381-2. ‡ Schnabel and Louis, Handbook of Metallurgy, p. 378.

crystalline, from 0·1 to rarely over 1 mm. in size. When magnified 60 diameters, they appear to be of uneven surface, showing planes which are too indistinct, however, for determining their form. They are greyish white, and of metallic lustre. It was impossible to select enough of the purest grains to determine their specific gravity, or to make qualitative analysis. A portion treated with HCl dissolved readily with disengagement of hydrogen, leaving fine scales of iridosmine behind. Not a trace of any other metal but tin could be found in solution.*

Dr. T. L. Phipson, F.C.S., &c., writing of native zinc and tin, stated :—

"I was surprised to find in this collection [Australian minerals at London International Exhibition of 1861.—J.E.C.] a specimen of native zinc. This is the first time this metal has been met with in nature in the pure state. The specimen, weighing perhaps 10 or 12 grains, is encrusted in a piece of basalt from Brunswick, near Melbourne, Victoria.

"Concerning native tin, it is evidently very rare in nature. Some years ago I noticed some small white grains in a sample of platinum ore from the Ural, which appeared to be metallic tin. Hermann had already met with this metal in small white grains in the gold deposits of Siberia, and recently M. Damour found it accompanying some gold nuggets from Guyana."†

Dana, who quotes the above, and also records occurrences with gold in Siberia, in Bolivia, and Mexico, refers to them all as doubtful.

J. C. H. Mingaye, during commercial assaying of tin ores in the early days of tin mining in this State "on several occasions observed the occurrence of metallic tin in the concentrated alluvial samples. The tin existed in small irregular grains, and had probably been reduced from the cassiterite by the action of bush fires."‡

It might also be pointed out that it is a common practice with fossickers when cleaning small parcels of alluvial gold to heat the panning dish over the fire before blowing to remove the heavy non-metallic particles which hang back with the fine gold in ordinary panning. Melted globules from the tin-plating may account for the somewhat globular grains of metallic tin with the gold referred to.

Tin Ores.

Cassiterite (tinstone)—Description (Dana)—Crystallization—Tetragonal. Cleavage, imperfect; lustre, adamantine; crystals, usually splendent; colour, brown or black, sometimes red, grey, white, or yellow; streak, white, greyish, brownish; nearly transparent to opaque.

Composition, tin dioxide, SnO_2 = Oxygen 21·4; tin, 78·6 = 100. Before blow-pipe alone unaltered. On charcoal with soda, reduced to metallic tin, and gives a white coating. With the fluxes, sometimes gives reactions for iron and manganese. Only slightly acted upon by acids.

Stannite (Dana).—Massive, granular and disseminated; cleavage, cubic, indistinct; fracture, uneven; brittle; lustre, metallic; streak, blackish; colour, steel-grey to iron-black, the former when pure; sometimes a bluish tarnish; often yellowish from the presence of chalcopyrite; opaque.

* Contributions to Mineralogy, No. XXIV, Proc. Am. Phil. Soc., 1886, XXIII, No. 121, pp. 20–47.
† Chem. News, 1862, VI, pp. 47–8. ‡ Verbal communication.

Composition, a sulphide of tin, copper, iron, and sometimes zinc; perhaps Cu_2S. FeS, SnS_2 = sulphur, 29·9; tin, 27·5; copper, 29·5; iron, 13·1=100.

In closed tube, decrepitates, and gives a faint sublimate: in the open tube, sulphurous fumes; before blow-pipe on charcoal, fuses to a globule, which in oxidising flame gives off sulphur and coats the charcoal with tin dioxide; the roasted mineral treated with borax gives reactions for iron and copper.

Decomposed by nitric acid, affording a blue solution, with separation of sulphur and tin dioxide.

Until the discovery of stannite in considerable quantity at Howell, New South Wales, and Zeehan, in Tasmania, this ore was too rare to have any commercial value. Attempts to treat it metallurgically at Howell have, so far, not been altogether successful, owing to the complexity of its associates, viz., lead, copper, iron, arsenic, silver.

Considerable interest centred in the recent efforts in that direction at the Oonah Mine, Zeehan, Tasmania, where a very similar admixture of ores occurs, with the addition of antimony and bismuth. (See p. 354.)

At Tolwong, in the Shoalhaven River Valley, near Bungonia, stannite occurs in lenses of ore in a very permanent lode fissure; here it is associated with arsenic, chalcopyrite and a little galena, but with a lesser amount of silver. This recent discovery is now being opened up, and the results of treatment are also awaited with interest.

S. Fawns points out that tin—

> "Is the rarest of the common metals of commerce, and is produced in markedly smaller quantities. Unlike most of these metals, it is distributed sparingly throughout the world, occurring in workable amounts at but few localities; where it does occur, however, it is generally, but not invariably, found in very important quantities.
>
> "Again, tin is the only common metal, except iron, the only true ore of which consists of an oxide of the metal. All other metals appear to have been deposited originally as sulphides, their existence in the oxidised state being due to the secondary action of atmospheric agencies upon these sulphides. Hence, the other metals are found as oxides near the outcrops only of their deposits, but as sulphides in depths; whilst tin appears as an oxide wherever it has hitherto been found, even in the deepest mines in which it has been met with, and at depths, where all other metals are known only as sulphides."*

The same authority points out the indifference of tin oxide to weathering:

> "The sulphides of the other ordinary metals, when exposed to atmospheric agencies form more or less soluble compounds; oxide of tin is notable for its great chemical indifference and for its insolubility in those reagents that dissolve most other metallic compounds. Hence, the degradation of a mineral deposit containing any of the other metals is apt to be accompanied by the removal in a state of solution of those other metals. In the case of tin it will only lead to a concentration and purification of the oxide. This is why oxide of tin (the tinstone or black

* Tin Deposits of the World, 2nd ed., 1907, p. 6.

tin of the miner, and cassiterite of the mineralogist) is found to so large an extent in alluvial grounds, a mode of occurrence that it shares almost exclusively amongst metallic minerals with those other chemically indifferent substances, gold and platinum."*

Canfieldite.†

Composition.—Sulphur 16·22, tin 6·94, germanium 1·82, silver 74·10, iron and zinc 0·21 = 99·29. Isometric, perhaps tetrahedral. Fracture uneven to small conchoidal. Brittle; hardness, 2·5–3. Specific gravity, 6·276. Lustre metallic, brilliant. Colour, black with bluish tint.

Before blowpipe fuses at 2 on charcoal, yielding a coating of the mixed oxides of tin and germanium, white or grayish near the assay, tinged with yellow on the edges. By long blowing a globule of silver covered by tin oxide is obtained. In the closed tube sulphur is given off, and at a high temperature a slight deposit of germanium sulphide. (Dana.)

Cylindrite.‡

Composition.—Sulphur 24·50, tin 26·37, antimony 8·73, lead 35·41, silver 0·62, iron 3·00 = 98·63. Massive; in cylindrical forms separating under pressure into distinct shells or folia, difficult to pulverise, like graphite. Soft —hardness, 2·5–3. Specific gravity, 5·42. Lustre, metallic. Colour, blackish lead-gray. Streak, black. (Dana.)

Franckeite.§

Composition.—Sulphur, 21·04; antimony, 10·51; tin, 12·34; lead, 50·57; iron, 2·48; zinc, 1·22; gangue, 0·71 = 98·87.

Massive. with imperfect radiated and foliated structure; in part in spherules aggregated in reniform shape. Cleavage perfect in one direction. Somewhat malleable, making a mark on paper. Hardness, 2·75; gravity, 5·55; lustre, metallic; colour, blackish-gray to black. Opaque.

Germanium is present in small amount (0·1 per cent.); also about 1 per cent. silver.

Before blowpipe on charcoal gives a yellow coating of lead oxide, and further from the assay one of oxide of antimony. In the open tube yields sulphurous and antimonial fumes. In the closed tube, a slight coating of germanium sulphide, if no air is present. Dissolved by nitric acid with the separation of a white powder (oxides of antimony, tin, and germanium); also readily in aqua regia with separation of sulphur. (Dana.)

Stokesite.‖

Composition.—Analyses of a minute quantity gave: Silica, 43·1; tin oxide, 33·3; calcium oxide, 13·45; water, 8·6 = 98·45.

Known only in a single crystal of acute pyramidal habit. Cleavage, imperfect. Fracture conchoidal. Brittle. Hardness, 6; gravity, 3.185. Lustre, vitreous. Colourless, transparent. (Dana.)

Tealite.¶

Composition (Dana).—Sulphur, 16·29; tin, 30·39; lead, 52·98; iron, 0·20 = 99·86.

Yields a little sulphur in the closed tube, but does not fuse; readily decomposed by hot hydrochloric or nitric acid.

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* *Op. cit.*, p. 6. † S. L. Penfield, Am. J. Sc., XLVII, 1894, p. 451. ‡ A. Frenzel, N. Jahrb. f. Min., 1893, II, p. 125. § A. W. Stelzner, N. Jahrb f. Min., 1893, II, p. 114 ‖ A. Hutchinson, Phil. Mag., XLVIII, 1899, p. 480. ¶ G. T. Prior, Min. Mag. XIV 1904, p. 21.

Occurs in thin folia, resembling graphite, embedded in kaolin, upon a dark gray matrix impregnated with pyrite ; also associated with wurtzite and with galena.

Cleavage, perfect. Hardness, 1–2 ; gravity, 6·36. Lustre, metallic. Colour, blackish gray. Streak black. Opaque.

V.—TIN DRESSING.

An attempt has been made to estimate the output of dressed ore from the State tin lodes since the commencement of lode-mining in 1882. Unfortunately a rough approximation only is possible, as the initial method of separate records for lode and alluvial soon gave place to general statements. From the early records, subsequent reports, verbal and other data, a rough total of 4,660 tons has been obtained; probably the actual total did not exceed 7,000 tons. From this small amount, and the meagre list of local treatment plants, of restricted capacity and employment, it is apparent that this branch of the industry has, so far, proved intermittent and relatively unimportant. Corporate undertakings in this field have been characterised by spasmodic effort, except in the case of the Ottery Mine, which was persevered with for a number of years.

Discontinuance of operations at the Ottery, according to Mr. J. H. Reid, the late General Manager, was caused by a serious accident to himself and the death of several shareholders. Reopening is shortly anticipated.

Most of the dressing plants were established at the beginning of this class of mining, and usually their brief careers ended with exhaustion of the only proved ore-shoot. In no instance did adequate proving precede, or keep pace with, surface expenditure and stoping, even in the few known cases which justify extensive prospecting.

Though, with the exception of the Ottery, operations on lodes with dressing plants connected soon closed, and only resumed at irregular intervals, individual miners—particularly in the Gulf districts—have continued work on smaller lodes, with primitive methods of crushing and concentration, whilst the conditions remained favourable. The aggregate output of small parcels thus obtained can only be roughly estimated. Indeed many, being so pure, were treated as "stream tin." Fortunately for the miner of small means, tin ore is of such value, and is saleable in such small quantity, that this branch of mining can be remuneratively followed with the simplest appliances —the most primitive and frequent method of crushing the lodestuff being by spalling and bucking hammers on a flat rock surface, after preliminary roasting if the material is hard. Improvements on this method take the form of raised bucking tables built of rough-dressed stone and capped by a single slab or an iron plate.

Intermediate between these primary forms and the modern stamp battery is the "Spring Dolly," an iron-shod wooden stamp worked by means of a spring pole. Examples may be seen at the Binghi Lode, Tingha, where horse-power gearing has been attached ; at the Brickwood Lode, Dutchman Lode, Sampson's Lode, Ruby Creek, Wilson's Downfall, and Crawford and Kohn's Lode, Jingellic.

Plants for Treatment of Lode Tin Ore—Cemented Alluvial Wash, &c., established in New South Wales.

Name of Mine.	Locality.	Battery or Mill.	Concentrating Machinery.	Date established.	Date of closing.	Remarks.
(?)	Near Bald Nob, Severn River	Huntington mill	Imperial Worthington table	1904	1907	Dodger rock-breaker.
(?)	Battery Mountain, Stannum	10-head stamp battery	.....	1876 (?)	....	Idle in 1887.
Butchart's	near Tingha	5 ,, ,,	.....	1879	1883	
Butler's	Mole Tableland, near Torrington	10 ,, ,,	.....	1885	1892	
Castle Wellington	near Stannum	Huntington mill	Frue Vanners	1890	1891 (?)	Rock-breaker.
Dutchman	Lottery Creek, near Torrington	5-head stamp battery	Jiggs and buddles	1883	1888 (?)	
Elliott's Lodes	Torrington	10 ,, ,,	.....	1906	1907	
Elliott's Lode	Cow Flat, near Torrington	5 ,, ,,	.....	1907 (?)	....	
Elsmore Valley Deep Lead	Elsmore	.....	.....	....	....	For cemented drift.
Gale's Lode	Stacy's Gully, near Stannum	J. W. Johns' patent breaker.	.....	....	....	
Grove's Bank	near Tingha	5-head stamp battery	.....	1875	....	
Gundle	near head of Wilson River	15 ,, ,,	Woodbury Vanners	1897	1907	
Gulf Stream Lodes	The Gulf, Vegetable Creek District	Chilian mill	.....	1877	1885 (?)	
Horse Creek	Jingellic East, Murray River.	Two 5-head stamp batteries.	.....	....	....	
Jingellic	Jingellic, Murray River	12-head stamp battery	Buddles	....	....	
Kangaroo Flat	Vegetable Creek	9 ,, ,,	.....	1878	....	For cemented wash-dirt.
Karaula	Newstead, near Elsmore	5 ,, ,,	.....	....	....	For cemented wash main y.
Lady Don	Euriowie, Barrier Range	Breaker and rolls	Jigs and Wilfley tables	1888 (?)	....	
Leviathan	Pine Ridge, near Inverell	5-head stamp battery	Wilfley Table and Frue Vanner	1901	....	
Mt. Euriowie	Barrier Range, Albert Division	Breaker and rolls	Jigs and Wilfley table	1888 (?)	....	
Mt. Tallabong	Condobolin District	13-head stamp battery	Wilfley and Krupp tables	1910	....	
Ottery	Tent Hill, near Emmaville	10 ,, (originally 15) battery	Jigs, Buddles, and Frue Vanners.	1882	1906	In 1887—10-head battery, jigs, and shaking tables.
Planet	Stannum	8 ,, battery	.....	1875	1876 (?)	
Rooney's	Moore Gully, near Tingha	5 ,, ,,	.....	....	....	
Silent Grove	Mole River	10 ,, ,,	Wilfley Table, Buddles	1877	....	5-head battery, Wilfley Tables and Buddles in use in 1905.
Stannifer-Bischoff	near Stannifer	5 ,, ,,	.....	1887	1888 (?)	
Stannum Lode	Battery Mount, near Stannum	5 ,, ,,	Wilfley Tables and Frue Vanners	1909	....	
Torrington	Torrington, Mole Tableland	5 ,, ,,	Buddles	....	....	
Victory	Clifton, Pulletop	4 ,, ,,	Wilfley Table	1909	....	
Wheal Byjerkerno	Euriowie, Barrier Range	Breaker and rolls	Jigs	....	....	4-head stamp battery erected in 1909.
Yankee Lode (Clifford's)	The Gulf, Vegetable Creek District	Sims' and Sons hand rolls	.....	1888 (?)	....	
(?) Border Lodes	Ruby Creek, Wilson's Downfall	3-head stamp battery	.....	1875	....	

To the spring dollies are sometimes added small hand-power rolls for fine crushing. At Clifford's Claim, Yankee Lode, The Gulf, Sims and Sons', small adjustable rolls with fly-wheel, geared for hand-power, is in use. The lode stuff is returned through closer adjustments, and finally sieved.

The most favoured crushing-machine is the stamp battery, which is so well known as not to require description. Mills, such as the Huntington, and, more rarely, the Chilian, have been used in a few cases; rock-breakers and rolls have also been locally tried.

Plate III is a photograph of an ingenious local adaptation of the Chilian mill principle, in which granite wheels, or grinders, take the place of steel, and a rock floor that of the pan.

Breakers and rolls with jigs and Wilfley tables were used at the Euriowie tin mines, Barrier Range, where coarse pegmatites and greisens form the lodestuff. The exceedingly large and tough mica plates in this ore caused considerable trouble in concentrating the tinstone from the crushed material.

In connection with the recovery and cleaning of alluvial tin ore from channel drifts, surfacing, &c., it may be pointed out that the process is a simple one, depending on the great specific gravity of the mineral (6·4 to 7·1), and yet one requiring considerable skill and practice in the final streaming or cleaning stage. In connection with dredges working under powerful pressure heads and dealing rapidly with enormous volumes of water-borne material, the most skilful hands are required in the boxes to prevent loss.

All the methods of ground and box sluicing, puddling, &c., in vogue in alluvial gold-mining were naturally applied to alluvial tin-mining when the rush for that mineral ensued in 1872. Altered conditions and greater experience led to modifications, principally in the size of the sluice-boxes; but the main principles of winning and dressing remained unchanged. The advent of the modern systems of sluicing and dredging led to new methods of maintaining efficient working pressure, or head, for breaking down, and the development of power for excavating and elevating, the separation or concentration of the mineral being effected as before, but on a scale proportionate to the increased power.

The introduction of forced steam pressure for the rare and seldom continuous head obtained from natural stream flow, revolutionised tin-mining in the principal tin centres, and led to the recovery of not only a large percentage of the tin lost in previous working, but of much ore leanly scattered through the overburden, the channel banks, and adjacent flats, which could not be remuneratively recovered by other means.

The efficiency of the powerful nozzle stream in breaking down and thoroughly disintegrating the wash and overburden, even when explosives are necessary to burst cemented layers, has rendered suction or pump-dredges most in favour with tin miners, thirty-one being in operation during 1909, as against two bucket dredges. In gold-mining the order is reversed, viz., seventeen of the latter to seven of the former.

Bucket dredges are very efficient, and possibly may be more cheaply worked under favourable conditions—a soft bottom, absence of high bars, and wash free from clay. The presence of high bars in a channel would be equally objectionable in the case of a floating suction dredge, but the nature of the conditions allows choice between stationary or floating plant of this type. The absence of any puddling power in the bucket type is a marked disadvantage compared with the suction.

The views accompanying this section speak for themselves, and obviate the necessity of descriptions of the types in use.

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Extemporised "Chilian" Mill, John Trewheelar's, near Torrington.

Tin Sluicing.

Tin Streaming, or Cleaning.

It is interesting to note that the principle of the "Willoughby" Cleaning Machine—extensively used in connection with dredging and hydraulic sluicing plants—was anticipated in 1873 by the late Mr. James Swales, who was interested in the newly opened tin mines. The first official notice of the "Willoughby" occurs in the Annual Report of the Department of Mines for 1878, p. 127.

The crude product of the mines was first shipped to England through Messrs. Harrison, Jones, and Devlin. To prevent loss in transit the ore, in canvas bags, was stowed in beer hogsheads.

In May, 1873, the firm instituted local sales by auction. It was soon found that much of the ore fell below the minimum standard—about 72 per cent.—and was penalized proportionately to depreciation below standard.

Mr. Swales thereupon devised a means of removing the heavy associates of the tin oxide which remained in the ordinary sluice-box.

It should, however, be pointed out that the defect lay in the inexperience of the operators in this class of concentration, and not in the sluice-box. Expert streamers can achieve equally good separation in the latter as in the Willoughby.

Utilising a natural waterfall at the head of Mossman's Bay—pointed out to him by Mr. A. H. Moore, now general manager of the above firm—Mr. Swales constructed a machine on the same principle as the "Willoughby," in which the natural head of water forced an upward flow through a perforated screen on which the charge was placed. The water jets agitated the particles, and worked those of lesser specific gravity to the surface, from which they were lightly scraped as in the present practice.

The inventor cleaned all his low grade consignments in this machine, and purchased others for treatment—the difference between buying and selling values affording a considerable margin of profit. He subsequently sold the machine to Mr. Moore for £5, who handed it to the late Phillip Sheridan, who became legal manager of the two principal mines at Quart Pot Creek (afterwards Stanthorpe), the Silver Tin Mine, and the Brisbane.

The concentrates from these properties are reported to have contained a considerable percentage of "black jack," very probably ilmenite, which is abundant in some of the leads in the adjacent Wilson's Downfall tin-field.

Mr. Sheridan brought the consignments up to grade in the Mossman machine.

In time marketable concentrates were produced at the mines as the streamers became more expert, and very soon smelting works were erected in Sydney.

At first £6 per ton was charged for a metallic recovery within 2 per cent. of the assayed contents; but competition soon reduced the charge to £2.

For a clue to the above interesting record the Writer is indebted to Mr. E. A. Ancher.

Treatment of Tin, Wolfram, and Copper-bearing Ore in Cornwall.

R. H. Couran, in a paper read before the Scientific Society, Broken Hill, New South Wales,* states:—

> "The method of treatment at the mill taking the ores from the Clitters group is practically the last word in Cornish milling practice. The ore contains cassiterite, wolfram, and copper sulphides. After passing over grizzlies, the ore is broken in Blake-Marsden breakers, and fed by Challenge suspended feeders to a battery of 25–1,100 lb. California

* Australian Mining and Engineering Review, I, No. 9, June 5th, 1909, pp. 279-282.

stamps, and there crushed through 20-mesh gun-metal wove screens. It is then classified in spitzlutten, giving three spigot products and an overflow. Each of the spigot products is taken to a Buss table, of which there are eight, the middlings from which are reground in a Krupp ball-mill, and afterwards treated on Luhrig vanners. The overflow from the spitzlutten goes to a ten-compartment condensing and classifying spitz-kasten. The various spigot products from the spitzkasten are taken to the distributing boxes of double Luhrig vanners, the product of the first three pairs of compartments going to three double vanners, and of the last two to one double vanner. The middlings from these four machines are treated on a fifth one, after some of the water has been eliminated in a spitzkasten. All the tailings pass to an eight-compartment spitz-kasten, 40 feet long, where a small quantity of lime is added. A large quantity of water is removed and pumped back to the storage tanks. The tailings pass on to dams, where they are settled, it being illegal to run solids into the neighbouring river.

"The concentrates from the Buss tables, being coarser and of a higher grade than those from the vanners, are roasted separately in a Brunton calciner. They then pass to a Wetherill Magnetic Separator of the cross belt type, which gives five products. In the first and weakest field, magnetic oxide of iron; in the second, other oxides of iron, with adhering oxides of copper; in the third, oxides of iron and wolfram; in the fourth, wolfram; the non-magnetic product being oxide of tin and a small proportion of siliceous waste.

"The copper and iron product from the second field is sold to the copper smelters. It contains up to 10 per cent. of copper, and realizes a good price, owing to the high percentage of iron oxide present. If there is too much tin and wolfram in the first two products, they are crushed dry in a ball mill, and then re-treated. The wolfram products are finished in kieves and sold.

"The vanner concentrates are at present further concentrated after roasting in buddles, then dried in a reverberatory drying furnace, and treated on the magnetic separator, giving similar products to the Buss table concentrates. The preliminary buddling is necessitated by the limited capacity of the magnetic separator. A second machine will probably be installed, when this mill will be avoided.

"The secret of the success of magnetic separation lies in the roasting, it being desirable to produce the greatest possible quantity of the higher oxides of iron, and at the same time eliminate the sulphur and arsenic. If the ore is rich in copper, the iron and copper products of the separator are treated with hot dilute sulphuric acid in a lead-lined vat, and the copper in the resulting solution precipitated on scrap-iron. All the water used in treating the roasted products is passed through precipitation tanks."

VI.—TIN-SMELTING.

Introduction of Tin-smelting in New South Wales.

The Writer is indebted to Mr. C. S. McGlew for the following particulars of the introduction of tin-smelting in the State:—

The first tin ore from Elsmore was smelted into bars by Milne Bros., brassfounders, &c., of Sussex-street, Sydney, about the beginning of 1872. (Mr. A. Milne states that the firm smelted a small button of tin from the

original sample obtained by the commercial traveller from the shepherd at Inverell; and afterwards small ingots from the first ore obtained by Brown, Barron, and Austin, these being used in connection with the first flotations.)

Milne Bros. erected two furnaces in Sussex-street, and both purchased ores, and smelted for the public for a period of about two years. Some of the first ore from Mt. Bischoff, Tasmania, was treated at their works.

Subsequently T. Carpenter erected a smelting plant at Pyrmont for Messrs. Metcalf, merchants; it was not, however, a success, the furnace being unsuitable.

This plant was afterwards taken over by the late T. H. Kelly, and reconstructed under Mr. Latta, as manager.

D. Eisenstaedter erected two furnaces at Johnstone's Bay, with solid iron dish bottoms.

T. Sampson, smelter, J. Meeks, and S. Low, put up furnaces at Pyrmont, near Kelly's, and reduced smelting charges from £5 to £2 10s. per ton. Eisenstaedter then closed his plant.

T. Saywell, with M. Constable, re-opened the latter, but did not operate long.

Low and Meeks eventually sold their site to the Colonial Sugar Company, leaving T. H. Kelly sole tin-smelter in the city.

Mr. Adam, M.P. for Northumberland, erected tin-smelting works at Stockton, but was not financially successful.

Mr. A. H. Moore states that C. J. Stevens started a smelting furnace at Stockton; the smelting charge being £6 per ton. S. L. Bensusan also erected a furnace at the foot of Bathurst-street in 1873.

It is probable that a small furnace was erected at George's River, to the south of Sydney, as samples of tin slag, containing prills of metallic tin, from that locality have been brought to the notice of the Department on several occasions, and also from St. Albans, on the Macdonald River.

Dr. G. Mackenzie, Manager of the Sydney Tin-smelting Works, Woolwich, under date March 27th, 1907, states that the occurrence of tin slag near George's River had been known to him for some time. The sample was rich, but, on inquiry, proved too limited in quantity to be commercially regarded. He understood some amateur smelting was carried on there shortly after the discovery of tin in the State. Of the St. Albans occurrence, he had no knowledge; the sample was rich, apart from the shots of tin showing. There is some possibility of tin slag having been conveyed to the latter as ballast in a small sailing craft, such as once traded up the Hawkesbury, and no doubt its tributary the Macdonald also.

So far as the Writer is aware, only two tin-smelting plants have been erected in the State outside of the centres mentioned. The first was the well-known Tent Hill, or Glen plant, established in 1874, four miles east of Emmaville, by Messrs. Moffat and Harridge, of Stanthorpe, which was subsequently enlarged to three furnaces, and maintained by the Glen Smelting Company, in connection with the Ottery Mine, and as a Customs works for the district until 1906.

The only other attempt to establish a local smelting plant was at Top Stannifer, in the Tingha–Elsmore district, in 1882; but its smelting campaign (with charcoal fuel) was exceedingly brief.

At the present date only the Sydney Smelting Works at Woolwich are in operation in the State.

The absence of local smelting plants—even if the ore supply was abundant—does not press on producers of tin ore as it does on those of other metallic ores, such as copper, lead, and antimony. The purity and value of dressed tin ore, and its relatively small bulk compared with its metallic contents, lessens the handicap of transit charges to a minimum.

Though from the purity of the furnace charge smelting may appear simple, yet from the behaviour of tin oxide at high temperatures as an acid or a base in the presence of silica or alkalies, the process requires great skill and experience to prevent undue loss in the slag, or formation of "hard-head" (tin-iron alloys).

As the metallurgy of tin has been recently dealt with in handy form by P. J. Thibault, F.C.S.,* and Donald Clark, B.C.E., † attention will be confined to a few common factors connected therewith.

First it is essential that tin ore be mechanically dressed to a high-grade; secondly, if deleterious mineral associates be present, as often is the case with lode tin, it should be roasted and leached with acids to remove soluble salts formed by oxidising roast.

Apart from the troubles entailed on the smelter, the producers of low-grade or contaminated ore are mulct in proportion to the fall below standard, or presence of impurities.

D. Clark states that the Mount Bischoff Company (Tasmania) buys large quantities of oxide, there being a deduction of 2 per cent. for loss on 72 per cent. ore and over; 3 per cent. on 65 per cent., and so on; the percentage loss necessarily increasing with the admixtures in ores, a 45 per cent. having 7 per cent. deducted. No base metal ores are taken. Cost of treatment slightly under £2 per ton.‡

Thibault states that "silica (quartz) in presence of basic substances, such as ferric oxide or lime, acts as an acid and combines with these and the tin oxide to form stannates or silico-stannates, which are unreducible under ordinary furnace conditions, and so enter slag. Tin ore, therefore, necessarily must be free from either acid or basic substances§—compounds which require very high temperatures to fuse them.

The smelting practice at the Glen Smelting Works, Tent Hill, in 1887, was described by David as follows:—‖

> "The reduction of the ore is effected in three reverberatory furnaces. These are constructed on the usual plan of an ore chamber, separated from the fire-place by a fire bridge, 1 foot high. The ore chambers, which are oval in shape, are from 14 to 16 feet long, and 6 to 8 feet in width. Their floors sink slightly towards the centre, and the arch, which is 2 feet high near the fire-bridge, slopes downwards towards the far end of the chamber—the object of this being to keep the flames from the furnace as close down upon the ore as possible. A flue at the far end of the chamber communicates with one of two brick chimneys, which are respectively 50 and 60 feet high. The outer walls of the furnaces are built of common brick, the sides, crown, bottom, flues, and all exposed parts being fire-brick. Owing to the great wear and tear of the bottoms and sides, the former are so placed upon iron supports as to be easily removed. The charge for each furnace is 4 tons, 3 tons of ore being mixed with 1 ton of ground charcoal. The charge, having been

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* Metallurgy of Tin (8vo. Melbourne, 1908). † Australian Mining and Metallurgy, (8vo. Melbourne, 1904.) ‡ *Op. cit.* p. 211. § Metall. of Tin, 1908, p. 5. ‖ Geol. Veg. Ck. 1887, pp. 154, 155.

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Glen Tin Smelting Works, Tent Hill.

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previously moistened with water, is shovelled into the ore chamber, in which heat is maintained by burning wood in the fire-place. The ore is then spread over the bottom of the furnace with a large iron rake or rabble, until it acquires a thickness of about 12 inches at the centre. The heat of the furnace is then gradually raised, the flames from the fireplace playing upon the surface of the ore, and passing through the flue at the far end up the chimney. The charge is stirred from time to time with a rake, especially during the last part of the smelting, and in twelve hours is thoroughly reduced. At the expiration of that time the furnace is tapped, the contents running into a cauldron or float of fire-brick, which is large enough to hold all the metal, and a small quantity of slag. The furnace, having drained, is ready for another charge, and by the time that has been attended to, the temperature of the molten metal has decreased to a point that will admit of removing the slight covering of the slag, without the risk of extensive oxidation. From this it is conveyed in iron ladles direct to the refining pots. These are cauldrons of cast-iron, three in number, capable of holding 5 tons of molten tin. The highly heated metal (previously placed in the $2\frac{1}{2}$-ton cauldron) is allowed to settle for some two hours, after which the upper portion of the metal is ladled into two smaller cauldrons, where, the temperature being lowered, boiling by the immersion of green billets of stringy-bark is resorted to. The green billets are kept immersed by an iron lever, and the steam escapes and causes a violent ebullition of the metal, thus oxidising any impurities, as also a large percentage of tin, which is afterwards recovered by furnace treatment. The metal, after having been boiled for four hours, is, when cold, generally soft enough to stand the bending test—this being always taken as the standard of quality. It is then ladled into cast-iron moulds, giving it the ingot shape. Each ingot so cast weighs 50 lb., and assays 99·5 to 99·8 per cent. of metallic tin. The ingots, having been carefully weighed, are packed, placed on drays and forwarded to Glen Innes. The load taken by each dray varies, of course, according to the state of the roads, the average load being 5 tons, drawn by eight horses.

"Since the year 1875, these works have been under the management of Mr. J. Reid, to whom I am indebted for much of the above information."

VII.—GEOLOGY OF NEW SOUTH WALES TIN-FIELDS.

A.—Emmaville (Vegetable Creek) District.

It has not been possible to prepare a general account of the geology of the tin-fields; it would entail a far more detailed examination of the New England Tableland than time would permit.

Attention has been directed mainly to the principal mining districts of Emmaville, Tingha, and Wilson's Downfall: these have been mapped, and brief descriptions of the general geology are included in the notes descriptive of the geological maps.

A detailed geological survey of the Vegetable Creek Field was made during 1884 and 1885 by David, and reference should be made to his report* for fuller information. The mining of the last twenty-three years has not led to any modification of his views.

* Geol. Veg. Ck., 1887.

Extracts from his general summary,* giving a review of the geological history of the Vegetable Creek Field, which may be regarded as typical of other fields, will be found on pages 107 to 121.

C. S. Wilkinson had previously made a brief examination of the Vegetable Creek Tin-field, and recorded its geology in the following terms:—

"The principal formations of this district consist of altered Silurian and Devonian sedimentary rocks (since determined on palæontological evidence to be Permo-Carboniferous.—J.E.C.), metamorphic, and intrusive granites, tertiary clays, and pebble drifts, and volcanic rocks. The tin-bearing lodes occur in the old sedimentary rocks and in the granites, but chiefly in the latter. These formations have suffered enormous denudation, for some of the valleys which have been eroded in them are more than 1,000 feet deep; consequently, the tin lodes which crop out in the sides of the valleys are but the remaining portions of those which have been broken up and carried away. We can readily account for the origin of the stream tin which has been concentrated, or, as it were, naturally ground-sluiced into the drainage channels. During the erosion of the valleys, volcanic outbursts took place, and the basaltic lava poured out and filled up some of the valleys, so that rain-water still falling over the same area had to cut fresh drainage channels, which were formed generally along the edge of the basalt or across it, and therefore we sometimes find the old river-bed or deep lead immediately beneath a hill or watershed between existing streams.

"Thus the lead of the Wesley Company's ground has been traced beneath some of the highest basaltic ridges in that locality, but such an occurrence is not a prevailing feature, for, further to the west, the same lead passes under several of the largest creeks in that locality. In some instances, as in the instance of the lead just mentioned, the newer channels have not been eroded down to the levels of the old ones; while in others they have been cut considerably deeper, in which case the old river-bed or lead may be opened by tunnelling in from the sides of the present valleys. In this district, therefore, where the denuding forces have operated so extensively, there are various tin-bearing drifts which have been deposited at different times, the tertiary deposits, generally covered with basalt, being the oldest, and the existing creek beds containing the youngest. . . . There are two main leads, one of which, consisting of rounded drift and sand, commences at the "Y" Water Holes, and runs westerly for several miles on the south side of Graveyard Creek; the other takes its rise in the Vegetable Creek Company's ground, near Emmaville, and extends with a winding but general westerly course to the Wesley Company's property, where it turns to the north for nearly half-a-mile, and then again westerly for about 5 miles, when it trends northerly for 5 miles towards Kangaroo Flat. There are several tributaries to it. From its source near Emmaville to Flannery's lead, in the Wesley ground, a distance of about a mile and three quarters, the sinking was dry and the lead very rich in places; thus, in the Vegetable Creek Company's ground 2,000 tons of ore are stated to have been raised from 5 acres.

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* *Op. cit.*, pp. 21, 22, 57 to 62.

"Several smaller leads or runs of tin-bearing ores have been found at higher levels, showing that on the top of the first basalt which covered up the main lead, the drainage waters of the country, still flowing down the same valley, deposited fresh drift from the adjacent hills where the lodes crop out. These newer leads, though not extensive, will be found in many places forming irregular deposits upon the uneven surface of the basalt."*

(*a*)—Vegetable Creek.

Early Tertiary physiography of Vegetable Creek Valley.

In the early Tertiary period immediately preceding the basalt outflow, the Tent Hill Range, which forms the watershed at the head of Vegetable Creek, was higher and broader than now. From its western slopes an ancient stream started near the present village of Emmaville, and from mining explorations along its course it is evident that it equalled, if not excelled, its successor in importance.

From the stockwork of thread-like tin veins traversing the rocks of the watershed was derived—by natural denuding and transporting agencies—the fine stream tin concentrated in the rich deposits of the "deep lead," or buried stream, and the present Vegetable Creek.

The richness of the past and present streams affords reliable criteria of the extent of denudation suffered by the watershed, for there is no ground for assuming the pre-existence of extensive lodes within it.

Prolonged stream action, during which basins or hollows were eroded in the softer rocks of the stream bed during great floods, lead to the formation of a series of ponds, linked by narrow defiles through the harder rocks, and as the heavy tin particles were current-borne into the deeper basins—where gravity overcame lessened velocity—a large proportion sank to bedrock and were held by the lower rim of the basin, just as riffles hold the ore in the artificial sluice.

In the narrow connecting channels, or "high bars," the reverse took place, the velocity and power of the confined stream overcame the gravity of the ore, and swept it on to the next basin. Hence the blank or barren patches frequently encountered in the leads, and the urgency of adequate and continuous prospecting ahead of blocking out.

Considerable thicknesses of sand, retained by the basin rim, frequently complete the basin filling. In times of partial drought, freshets introduced fine suspended clays and organic matter into the almost currentless ponds, which gradually subsided to form the pipe-and-carbonaceous or lignitic clays overlying the lead drifts. Over these, lesser floods frequently deposited sands and even coarser drifts, whilst yet again the finer sedimentation prevailed. Finally a sudden outburst of volcanic lava ended its career by filling the channel with basalt, and partially filling the valley, but insufficiently to entirely alter the drainage, for later streams flowed over the basalt, eroding channels into which stanniferous detritus gravitated from the watershed, thus forming the "shallow" leads—the lapse of time being indicated by their erosion and filling.

A later volcanic outflow completely filled the old valley, diverting the drainage to form the present Vegetable Creek, which has lowered the original watershed, and cut its head back eastward of that of the ancient stream, whilst deepening its channel to lower levels than the pre-existing valley. It is interesting to note that though its tributaries have deeply intersected, and

* Ann. Rept. Dept. Mines N. S. Wales for 1883, p. 148.

in places almost dissected, the basalt filling of the ancient valley—occasionally revealing the margins of the buried stream—the new Vegetable Creek has sawn an independent track through the northern wall of the old valley.

Immediately at the head of the present stream, a wide sheet of alluvium and tin drift was deposited from the watershed, through which the stream head deepened its track and concentrated some of the contents into the rich deposits of the early workings in its bed.

General Geology.*

"The various physical features of the district, as sketched above, are intimately related to its geological structure.

"The following is the provisional classification proposed for the rocks of the Vegetable Creek district :—

"*Classification of the Vegetable Creek Rocks.*

"Post-Tertiary.—Post-Pliocene : Holocene or Recent Pleistocene—Clay, sand, gravel, and rubble ; occurring in small swampy flats, near the sources and along the banks of creeks, or in open plains along the valley of the Dumaresq River ; usually more or less stanniferous. Living species of freshwater shells, and natives' stone hatchets are associated with these recent deposits. Area, about 9 square miles ; thickness, from 1 foot to at least 20 feet.

"Tertiary.—Pliocene (?) : Coarse river gravel, overlying basalt. Area, 9 acres ; thickness, 10 (?) feet. Eocene, in part. 3. Basalt, capping the tin sands of the 'deep leads'; in some places overlying, in others underlying the laterite ; characterised by fine open country, flat, and timbered with white box, white gum, and apple. Area, 53 square miles 260 acres ; thickness, from a few feet to about 300 feet. 2. Laterite, locally known as 'red clinker' or 'ashes,' consisting of red and yellow beds of volcanic dust and scoriæ, passing in places into an earthy pisolitic ironstone ; overlies or is inter-stratified with the basalt ; characterised by scrubby country, with red dusty or cindery surface. Area, 11 square miles, 577 acres ; thickness, 30 to 40 feet. 1. (*b*) Gravel, sand and clay of the deep leads, mostly capped by basalt or laterite, but partly interstratified with the volcanic rocks. The oldest of the clay beds enclose fossil leaves, probably of Eocene age. Thickness, from a few feet to 80 feet ; area, unknown, as the underground extent of this formation is hidden by the volcanic rocks The total length of these beds is 49½ miles. 1. (*a*) Quartzite and sinter, locally called 'grey billy,' occurring in irregular patches and concretions in the deep lead gravels, especially near the junction of the latter formation with the basalt. Area, about 40 acres ; thickness, 1 foot to 5 feet.

"Age unknown.—Diorite dykes, greenish grey, possibly connected with the eruptive rocks of tertiary age. Hypersthene-garnet-diorite, dark green, occurring as metalliferous dykes, containing sulphide of zinc, copper pyrites, and a little silver.

"Palæozoic.—Permian (?) : 2. Granite (*b*), coarse-grained and intrusive, traversed by veins of eurite and quartz containing tinstone, associated in places with wolfram, magnetic, and iron pyrites, arsenical pyrites, and to a limited extent with bismuth and molybdenite. Seen from a distance shows smooth outlines, rising here and there into bold isolated hills, which latter on nearer view have a rugged aspect, being

* David, Geol. Veg. Ck., 1887, pp. 21, 22

built up of huge dome-shaped masses of nearly bare rock. The prevailing timber is stringybark and pine. Age unknown. (*a*) Intrusive hornblendic granite. Total area, 297 square miles.

"Age unknown.—1. (*c*) Intrusive red quartz-porphyries, containing red orthoclase, and passing into aplitic granite. (*b*) Intrusive white quartz-porphyries. (*a*) Intrusive hornblendic quartz-porphyries and breccias, associated with grey and dark blue porphyroids. The age of the porphyroids is unknown. The tin-bearing portion of the hornblendic quartz-porphyries, which pass into euritic granite, may perhaps be correlated with the tin-bearing granite. It is characterised by sharp-edged cliffs, the rock coming generally to the surface, and splitting into large harsh blocks, affording scant nourishment to stunted trees of ironbark and red gum, and an undergrowth of dogwood and grasstree. Area, 71 square miles.

"Palæozoic.—Upper Silurian [or Siluro-Devonian] (Permo-Carboniferous.—J.E.C.)* Yellowish brown to olive green clay shales, passing into dark blue and black claystones with bands of leaden-grey felspathic quartzite, and beds of dark grey pebble conglomerate. An interstratified bed of blue siliceous grit shows casts of bryozoa and minute shells. The dark shales in one place show obscure traces of plant remains. The formation is characterised by sharp crested hills of blue claystone and olive green clay shales, timbered with ironbark and red gum. Area, 234 square miles; thickness not ascertainable, owing to the folding and dislocation of the beds, but probably not less than 5,000 feet.

"Age unknown.—Porphyrite: A dark bluish-black to greenish-black rock, in appearance somewhat resembling basalt, but containing large glassy crystals of felspar and hornblende crystals, partly altered into epidote. The joints in this rock in places are filled with thin seams of epidote. Area, 18 square miles. Granite, metamorphic (?): A fine-grained leaden-grey rock, consisting of an intimate crystalline admixture of felspar, quartz, magnesian mica, and hornblende. There is a gradual transition from this rock into the porphyrite, and it may represent the extreme stage of alteration of the Upper Silurian rocks. No metalliferous deposits have been found in this rock in this district. The country occupied by this formation is characterised by undulating hills, thinly timbered with peppermint, and by open grassy plains. Area, 62 square miles."

Several typical porphyries and a tuff have recently been examined petrologically by G. W. Card from the north-western portion of the Vegetable Creek area:—

[**7918.**] On Bonshaw-road, between Hodge's and Gros' homesteads.—Felspar-Porphyry.

A dark gray ground mass, thickly studded with white felspar crystals, up to 2 mm. in length.

Calcareous areas throughout.

Under the microscope the ground mass is micro-crystalline.

Oligoclase and orthoclase are present, and there are occasional zenoliths.

[**7919.**] As above.—Quartz-Felspar-Porphyry.

A red, rudely jointed rock.

Much dull red, cleaved orthoclase, with some quartz, in a red groundmass. Orthoclase crystals up to 1 cm. in length. Groundmass and phenocrysts are about equal in volume.

*See pages 68–70.

Under the microscope the orthoclase is seen to be more or less clouded. and to show broad opaque marginal zones. Quartz is typically corroded, The groundmass is cryptocrystalline.

[7920.] Hetherington's Peak, on Bonshaw-road.—Granite-porphyry.
A red, rudely jointed rock.

Quartz and flesh-coloured orthoclase are rather sparsely distributed through a very finely crystalline groundmass. The phenocrysts measure up to half a centimetre in length.

Under the microscope the groundmass is micro-granitic and occasionally micro-graphic—round phenocrysts of quartz. The felspar phenocrysts are completely clouded through alteration.

[7921.] As above.—Quartz-Felspar-Porphyry.
A red, well-jointed rock.

[7922.] Near Rocky Creek Homestead.—Quartz-Felspar-Porphyry.
Creamy opaque felspar phenocrysts, with some quartz scattered somewhat sparsely through a stony ground mass.

Under the microscope the groundmass is micro-crystalline, and contains wisps of biotite. The felspar is completely clouded.

[7925.] On Bonshaw road, in Parish Bowman.—Volcanic Tuff.
A gray rock, mottled with abundant opaque white felspar, and breaking with a very irregular fracture.

Under the microscope a few volcanic particles are seen, but the mass consists essentially of felspar particles.

[7924.] Near Rocky Creek Homestead.—Micrographic Granite-Porphyry.
Flesh-coloured and white felspars, together with quartz and a little mica, in a finely crystalline groundmass.

Under the microscope all the felspar—both phenocrysts and that in the groundmass—is thoroughly clouded through alteration. The groundmass is micro-graphic throughout, and contains a little biotite.

[7923.] Near Homestead, Rocky Creek. Quartz-Felspar-Porphyry.
Jointed rock, yellow-gray in colour, due to abundant yellowish-white felspars in a gray groundmass.

*General Summary.**

"Such scanty observations of the general geological features of the district warrant no more than provisional inferences as to its past physical history. The following conclusions must therefore, be accepted as put forward in a tentative manner, subject to future correction or alteration.

During a time, belonging probably to the close of the Upper Silurian, or the beginning of the Devonian period [Permo-Carboniferous.—J.E.C.] clay, sand, and gravel were drifted down from an old land surface and deposited on the floor of a shallow sea; the fossils (bryozoa, &c.) in the beds show that these strata were of marine origin, and the ripple marks prove that the water in which they were laid down was sometimes shallow. The fineness of some of the laminæ of the chert beds, and the regular alternation of the felspathic

* Geol. Veg. Ck., 1887, pp. 57-62.

quartzite bands with the claystone, show that the conditions under which these marine sediments accumulated were probably tranquil. At times, owing to oscillations probably in the level of the land, coarser sediment would be drifted in amongst the fine clays, and beds of coarse gravel would be laid down at no great distance from an old shore line. The pebbles of quartzite and mudstone in these gravels record the nature of the rocks forming that shore. These layers of sediment were slowly piled upon one another until they acquired a thickness of at least 5,000 feet. At a period previous to the intrusion of the tin granite, these strata, now hardened into rock by heat and pressure, were gradually bent into broad folds by slow shrinkage of the earth's crust, the axes of the folds running about 27° west of north and east of south. This crumpling of the strata was accompanied by intense normal metamorphism, whereby the Silurian claystone and pebble conglomerates were converted into crystalline rocks, showing every gradation of structure from a slightly crystalline porphyroid to a crystalline granular granite. The later part of these periods of metamorphism was marked by a violent forcing up of the underlying dissolved rocks, through the harder and less altered upper portions, in the form of dykes, masses, and sheets; and if the occurrence of tinstone is to be taken as a test of contemporaneity of origin, the uplift of the Mole Tableland, and the rise of the quartz felsite dykes and sheets near Emmaville, and between Strathbogie and Bough Yard Creek, belong to this same period. The formation of all the tin veins probably belongs to the same date. The already contorted Silurian strata were still further cracked and bent by this forcible upheaval of the tin granite, and its associated dykes. The latter burst out along lines chiefly 40° north of west and south of east and 33° north of east and south of west, the granite being cleaved 31° east of north and west of south, and 40° south of east and north of west, and the quartz-felsites and claystone 20° north of east and south of west, and 20° west of north and east of south. Whether any of the quartz-felsite dykes reached the surface and poured forth flows of lava, is doubtful. Strong evidence is afforded by the beds of coarse volcanic agglomerate and volcanic breccia, and the glassy nature of some of the felsites, of the existence here of true acid lavas; but the date of their eruption has not been fixed further than that it was earlier than the Tertiary, and not older than the Permian. [*See* "Mines and Minerals Statistics" of New South Wales, for the year 1875, page 80, Geological Surveyor C. S. Wilkinson's Report.]

"Mr. Herbert S. Cox, F.G.S., F.C.S., &c., has lately suggested that part, of the quartz-felsites near Emmaville belong to the epoch of volcanic activity in the early Tertiary time which has produced the basalts [a view which has been found untenable.—J.E.C.] In this case the felsites must have been nearly contemporaneous with the basalts, and represent the earlier products of the eruptions. If they are true lavas erupted at the surface, it follows that before their flow the Silurian strata must have been subjected to extensive denudation, for the sheets of quartz-felsite rest horizontally or at low angles on the truncated edges of the Upper Silurian claystones. In this case deposits of stream tin may be found under the quartz-felsites, if at any point in this stanniferous district they are found to overlie contemporaneously-formed gravels. This point might be settled by searching along the junction lines of the quartz felsite and the claystone, for an outcrop of such a gravel, and if any can be found, the gravel or pebble con-

glomerate can then be tested for stream tin. The sections afforded by the Beardy River, near the infall of Swamp Oak Creek, offer great facilities for such an examination. At all events the elevation of the Silurian rocks and, perhaps, newer overlying strata, took place probably not later than the formation of the tin veins during the Permian period. From the Permian period, however, to the commencement of the Tertiary era there is a vast gap in the geological record. The diorite and hypersthene dykes, and perhaps some of the felsites, and the metalliferous veins which have a north and south strike, are probably newer than the granite; but with the exception of these igneous formations the district has no representatives of the rocks of the Mesozoic era. During the greater part of that vast period of time the surface of the land was being slowly broken up and worn down by the action of rain, frost, sunshine, vegetation, and perhaps marine erosion, until a land surface was evolved, which in its broad features resembled the present. Vast thicknesses of sedimentary material having been removed by these means, the underlying crystalline rocks were laid bare, and, erosion proceeding still further, the crystalline rocks themselves and their metalliferous veins became disintegrated, and their materials transported and redistributed by water. In this way were formed the deposits of gravel of which the outliers at Scrubby Gully and Ruby Hill are the insignificant remnants. The intensely worn surfaces of the pebbles in this gravel, and the fact that only the hardest and most indestructible minerals, as quartz, tinstone, and gemstones, &c., have survived in them, shows that they must have been subjected to a long process of battering and bruising, in which the weaker pebbles of claystone, granite, &c., were completely pulverised. The only power in nature capable of doing such a work is the sea, where it breaks on a rocky coast. These Tertiary gravels are therefore probably of marine origin, a fact of great significance, as bearing upon the probable richness of stream tin of the "deep leads," for marine beds must have had a wide extent, and the great richness of these small outliers favours the expectation that the far larger portions which have been swept away were equally rich; so that large bodies of ore derived from this source must have gravitated into the lower level gravels subsequently buried under lava. [Subsequent geological evidence is opposed to marine action.—J.E.C.] As the land continued to rise, the sea would recede further west; and the rivers being increased in size and power, subaerial degradation would proceed more rapidly. The channels of the rivers would be continually deepened, and the whole surface of the land gradually lowered to adapt itself to the increasing fall of the rivers. The three terraces of gravel at the Surprise Mines mark the levels at which the bottom of a large river stood at three successive epochs. What was the exact configuration of the country at the time of the first outburst of the basalt lavas, geological evidence fails to tell. That part only which has been sealed up under the lava sheets has been preserved to the present day, and its shape is being gradually restored by the workings on the 'deep leads.' The results of these subterranean explorations tend to show that most of the country now covered by lava sheets, and forming in places main lines of water-parting, was at that time near to, or part of, the principal drainage channels, and that the trend and fall of these old rivers agreed approximately with that of their nearest modern equivalents. Of course, there are no exact modern representatives of these old streams, nor is it always possible to determine even approximately with what

present rivers they should be correlated. At the Fishing Grounds, however, near Kangaroo Flat, there can be no doubt that the old stream, which produced the coarse shingle now capped by lava, was related to the present Beardy River. The bottom of the channel of the Beardy at the nearest point, 1 mile distant, is now 550 feet below the level of the bed of this buried river channel. The flora of the period, to judge from the number and variety of leaves entombed in the Eocene pipeclays, was rich and diversified. The fossils are chiefly leaves of herbs, trees, and ferns, some having fruit, and one a blossom delicately preserved. At Rose Valley, near Emmaville, the vegetable matter has almost entirely disappeared, the cast only remaining in the white pipeclay, which is stained a rusty yellow where it has received the impressions of the fossils. At Witherden's tunnel, in portion 50, parish of Hamilton, the fossils are enclosed in a dark brown fine sandy clay, the original material of the leaf being preserved; and at the head of the Wellington Vale Lead leaves are similarly preserved in a hardened black silt. Impressions of fossil insects have been found on the Red Hill, near Emmaville, the markings being plainly visible in fine brown earthy ironstone; but these belong to the later part of the Tertiary volcanic epoch. At a time then when the physical features of the country were somewhat similar to what they are now, and its surface, probably some 20 feet or so higher than at present, was covered with an Eocene flora, volcanic energy revealed itself in the first eruptions of basalt. The hard rocks of the quartz-porphyry, felstone, and granite were rent open; and, where the volcanic forces became centralised, small cones were thrown up composed of comminuted fragments of the underlying rock and scoriaceous basalt. The lava emanating from these centres, poured into the valleys in streams from 100 to 200 feet thick, flowing for a distance of from 6 to 12 miles. Dispossessed of their old beds, the creeks and rivers had to wear for themselves fresh channels, either down the centre of the lava stream or along one or both of its margins. It is probable that, in accordance with facts observed in connection with recent lava streams, the sides of these old basalt flows in contact with the cold rim rocks would cool and consolidate, while the centre of the mass was still fluid. The result of this would be that the centre of the stream would flow away from the sides, leaving them at a higher level, and so giving rise to a slight central depression. This would favour the erosion of the new channel immediately over the site of the old one, where the lava must necessarily have been thickest and so most fluid, and where consequently the lowest point of the depression should lie theoretically. More frequently, however, the water chose the junction lines of the basalt with the palæozoic rocks. That the volcanic activity was prolonged for a vast space of time is proved by the extent of denudation which has taken place between the older flows of lava and the newer. The amount of this can be measured at the upper end of the Vegetable Creek Lead at Rose Valley. The section at Griffith's and Fox's shafts shows that a watercourse has cut through one or more flows of basalt altogether to a depth of about 60 feet. Then succeeded another flow of basalt, which buried the second channel to a depth of 100 feet. These second eruptions appear to have been less violent than the first, the lava welling up, probably from wide rents, and producing the low gently sloping cones of solid lava, destitute of the volcanic dust and scoria characteristic of the earlier outbursts. Evidence as to which is the latest flow of basalt

is rather meagre, but judging from the general freshness of the appearance of the lava at Kangaroo Flat, in portion 70 and 73, parish of Arvid, it seems to me that this flow is one of the most recent. Powerful streams must have flowed in places over the surface of the basalt long after its consolidation, as evidenced by the coarse Pliocene gravel in portions 696 and 751, parish of Strathbogie, where some of the water-worn blocks are over 1 foot in diameter. This gravel is, roughly, about 150 feet above the Severn River. At the time such a coarse gravel was formed it is scarcely conceivable that the present Severn Valley existed, and its erosion was therefore probably subsequent. Here, however, a question of great difficulty arises. The statement already made that most of the present river channels have been deepened by from 300 to 600 feet since the last lava flows, is generally correct; but what appears to be a remarkable exception to the general rule occurs at Strathbogie. For about a mile above the head station basalt occurs in position a few feet only above the level of the present river; and, on the left bank of the same river, a shaft sunk through the lava proves that it extends to a considerable depth below the river channel. Also on Swamp Oak Creek, 1 mile north of the north-east corner of portion 5, parish of Astley, the basalt comes down within a few feet of the level of the creek. In the latter instance the position of the basalt may be partly due to landslips; but the first case is incapable of such an explanation, and the interpretation of this phenomenon must be deferred until a geological examination is made of the country south of the Severn River.

"These patches of Pliocene river gravel show that at the close of the Tertiary volcanic period the outpouring of the lava streams by filling up the valleys had locally raised the level of the drainage channels. Running water, however, ceaselessly fretting the rocks, by degrees wore fresh troughs as deep as the old ones, and eventually considerably deeper. The heavy rainfall of the Pleistocene period must have materially accelerated this work of erosion; but in this rocky district, with its steep falls, little trace is preserved of Pleistocene deposits, except in the wide plains of coarse gravel in the valley of the Dumaresq. The shallow deposits of subangular gravel and sand in the beds of the present creeks and rivers were evidently formed under conditions similar to those which now obtain; and their stratigraphical position, as well as the occurrence in them of natives' stone hatchets, proves them to belong to the recent period."

Quartzite, or "Grey Billy" as it is known to miners in the Vegetable Creek district, occurs in numerous localities in granite country wherever basalt has overspread it; when weathered and lichen-covered it closely simulates granite to the superficial glance. Professor David described the Vegetable Creek rock in the following terms, which apply equally to other occurrences:—*

"The rock consists of water-worn sand grains and stream tin, firmly cemented into extremely tough stone by a milk-white or pink chalcedony. From its distribution along the lines of junction of the basalt with the underlying and overlying gravels, there can be no doubt that it is intimately connected with the basalt, and was formed either at the time

* Geol. Veg. Ck., 1887, p. 45.

the basalts flowed, by the infiltration of superheated waters carrying silica in solution as they escaped from the lava, or from hot springs which would break out along the lines of volcanic fissures after the extravasation of the lavas had ceased."

Typical examples are exposed, near Delungra, resting on the Dumboy–Gragin granite, where denudation has removed the basalt sheet, the Newstead granite near Elsmore, and at Boney's Gully, between Elsmore and Stannifer.

A different phase of cemented rock, however, occurs at Newstead and Elsmore, angular instead of water-worn, sand grains forming the mass. A careful study of these confirms L. A. Cotton's view, that the cemented rock has been formed from the residual quartz resulting from the decomposition of granite *in situ*, after removal of the less resistant felspar.* The puzzling feature of quartz-reefs in this evidently recent rock at Elsmore Hill is thus merely survival intact of the most resistant bands above the general level of weathering, and subsequent cementation of the residual quartz grains enclosing them by siliceous waters following the basalt. Abundant silicified wood, common opal, chalcedony, agate, &c., which form common features of basalt flows, afford additional evidence of the siliceous solutions following basalt extravasation.

(*b*)—Tingha–Inverell District.

C. S. Wilkinson, Geological Surveyor and Government Geologist of New South Wales from 1874 to 1891, practically began his geological studies in the State at Cope's Creek, where he was engaged in ordinary land surveying in 1872. He gave great attention to the rapidly developing tin-mining industry, and predicted the payable deep leads beneath the basalt in the district.† In 1883, with T. W. E. David, he spent eight weeks mapping in the leads with a view of preparing a map of the tin-field and a descriptive report. Unfortunately the work was not completed, and much ripe judgment was lost to the industry. In 1895 the incomplete rough sketchwork was pieced together by Mr. O. Trickett, L.S., and published. In this map no distinction is made between basalt flows and Tertiary deposits, beyond a little rough hatching in places indicating basalt. As the outlines of the latter are economically more important, inasmuch as the basalt sheets cover earlier drainage channels (leads), they have been defined on the present map ; whilst the recent alluviums, such as those along the Macintyre River, which shroud the basalt, are ignored as they are non-stanniferous.

Though Mr. Wilkinson failed to record his maturer views of tin-occurrence, as intended, he left in an earlier work‡ an epitome of his conclusions on the geology of the area embraced in the present map of the Tingha–Inverell Division, from which the following is extracted :—

> "That portion of the tin-bearing country which lies chiefly to the south and east, and within a radius of about 25 miles from Inverell. . . . The principal tin mines within this area are those on Cope's Creek, Middle Creek, and on the Macintyre River at Elsmore and Newstead. . . . .

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* The Tin Deposits of New England, Proc. Linn. Soc. N. S. Wales, 1909, XXXIV, pt. 4, p. 747. † Ann. Rept. Dept. Mines N. S. Wales for 1876, p. 69. ‡ Tin-bearing country, New England. Legislative Assembly papers, 181—A, 1873.

"For clearness of description it may be well to arrange the formations separately in the following order:—

Recent	... ...	Quarternary.
Pleistocene Pliocene Miocene	... ...	Tertiary.
Carboniferous Granite Greenstone.	... ...	Primary.

"I would here premise that, in using the above terms, Pleistocene, Pliocene, &c., I do so in a measure provisionally, as expressing the relative ages of the formations to which they are applied. . . . .

"*Recent.*—Embrace all those river drifts, alluvial and other surface accumulations, which are in course of formation at the present time.

"*Pleistocene.*—Includes those drift deposits forming alluvial flats which are found more or less in all the valleys, and through which most of the present streams have worn their channels. They consist of gravel, sand, clay, and loam, varying in arrangement, and their composition depending very much on the nature of the rocks from which they have been derived. Thus in granite country the detritus is of a coarse, sandy character, with a little quartz drift; that from the older Tertiary formation consists chiefly of water-worn gravel and sandy ferruginous clays; from the basaltic trap have resulted thick deposits of black and red loamy clay, affording a very fertile soil, and those extensive alluvial flats along the Macintyre River are formed of the detritus from all these rocks, together with that brought down by the river from other formations in distant localities. In the valley of the Macintyre, as in the river valleys in other parts of the Colony, several of these alluvial deposits occur at different heights, forming terraces on the sides of the valleys.

"In the creeks and gullies traversing the granite country the alluvial deposits are all tin-bearing, but, being often of considerable thickness—sometimes 20 feet—are not so easily worked on account of the great amount of stripping required, as the shallower and more recent drift along the beds of the creeks.

"Besides the alluvia along the creeks, several rich patches from 1 to 4 feet thick have in various places been opened, the wash-dirt requiring but little 'stripping,' and yielding from 15 to 30 lb. of tin ore to the cart load of dirt.

"The richness of these surface deposits, together with the angular form of the tin ore, often indicates the proximity of lodes in the underlying granite, to the breaking up of which the supply of tin ore is due. Owing to these numerous tin veins or lodes, the surface soils, where derived from the granite, has been found almost everywhere to contain tin ore.

"*Pliocene.*—Next in order of sequence is the basaltic trap. For the miner this volcanic rock has but little interest, but to its influence the best pastoral and agricultural land chiefly owes its fertility. (Written before the stanniferous deep leads beneath the basalt had attracted the miners' attention.—J.E.C.).

"Near the junctions of Newstead Creek with the Macintyre the basalt appears to have filled up an old valley, and the same features are noticeable further down the river, near Brodie's Plains, and again at Inverell.

An examination of the country to the eastward may possibly show this old valley to have been in Pliocene times that of the Macintyre, down which the basaltic lava stream poured, and damming it up, caused the drainage water to erode a fresh channel, forming the existing valley, which during the succeeding Pleistocene and recent times has not been deepened to the level of the old valley. . . . . As, therefore, these leads (Lucknow, Gulgong, &c.—J.E.C.) traversing gold-bearing formations have been found highly auriferous, it is not improbable that the Newstead one may contain payable stream tin, provided, of course, that it has passed through stanniferous granite country. (A clear prediction of the Newstead and Elsmore deep leads subsequently discovered.—J.E.C.).

"Another small lead, covered with basalt, occurs between Middle Creek and the Macintyre. It runs in a north-westerly direction, between two granite ranges, until it enters the Macintyre Valley.*

Of the Cope's Creek stanniferous drifts in an earlier report (1872) Mr. Wilkinson wrote :—

"As before mentioned, some of the hills north of Cope's Creek are capped with deposits of gravel and ironstone. These are of Tertiary formation, and in lithological character resemble the older Pliocene drifts and leads of Victoria. Exactly as we should expect, therefore, I have observed in these hills patches of very water-worn gravel, which appear to be the remains of an alluvial lead or watercourse, that in the older Tertiary period flowed across the country now occupied by a very different system of drainage. Near Cope–Hardinge Mine a small patch of this water-worn drift occurs, which the prospector of it informed me yielded from 4 to 15 lb. weight of stream tin to the dish; but being cemented could not be well sluiced without crushing. About half a mile to the south the drift is seen again, partly covered by a flow of basaltic lava. This lava stream, as is frequently the case in Victoria and elsewhere, may indicate the course of the old valley down which it flowed.†

"*Miocene.*—The rocks of this period are of much economic importance, on account of the valuable deposits of stream tin which some of them contain.

"Certain of these rocks are full of the impressions of leaves and plant stems, which are believed to be of lower Miocene age. . . .

"The formation must have been of considerable thickness, and seems to have once covered nearly the whole district, for it is found on the summits of hills, and again filling some of the intervening depressions. The upper part consists of sandy concretionary ironstone, which sometimes assumes a pisolitic structure, from the small ferruginous concretions composing the mass. Where this is the case, the surface of the ground is often strewn with small round ironstone pebbles of the size of a pea. The ironstone is now chiefly found in outliers forming those 'red hills,' as they are locally called, which constitute such marked features in the country between the Macintyre and Cope's Creek.

"Underlying the ironstone are red and white sandy clays, and beneath these water-worn drifts and conglomerates, the latter usually occupying the sides and bottoms of the ancient valleys, and containing the tin-bearing deposits.

* Tin-bearing country, New England. Legislative Assembly Papers, 181—A, 1873, p. 3. † Report—Tin-bearing country, District of Inverell. N.S. Wales Leg. Ass. Papers, 176-A. (Sydney, 1873).

"Owing to the enormous denudation this formation has suffered; the overlying clays and ironstones have in places been entirely removed, leaving the stanniferous gravels exposed near the present surface, and, therefore, easily accessible to the miner. Such is the case at Elsmore, Stannifer, and other important tin mines.

"At the Elsmore mine this old alluvial drift has been broken up and re-deposited, forming shallow surfacing near the top of a hill, where it is now being worked, but in another part it lies undisturbed, and consists of a hard conglomerate, the waterworn boulders being cemented together with siliceous cement.

"The hill on which the drift occurs (Elsmore Hill.—J.E.C.) formed the south side of one of the above-mentioned old valleys; the drift, therefore, deepens as it is followed to a lower level, and there is every probability that the wash will not decrease in richness, though the amount of stripping will be greater. The same description of conglomerate as that at Elsmore is to be met with again about 3 miles to the eastward, at the Karaula Tin Mine; it is rich in very water-worn stream tin, and I have seen specimens of it also enclosing coarse specks of gold with the tin ore.

"The surfacing at the Stannifer Tin Mine, Middle Creek, is the remains of an old lead, through which the present valley has been eroded, thus leaving the gravelly bed of the old stream now in disconnected patches amidst the hills. Water-worn pebbles and boulders, up to 1 foot or more in diameter, of quartz and quartzite, compose the drift, which in places is cemented into a hard ironstone grit and conglomerate. . . . I have traced this lead for about 2 miles to the westward, where it has been opened by Messrs. Burlington and Low. . . . For some distance further to the westward this lead has been removed by denudation; but the red hills on the south-west side of Middle Creek suggested its continuance in that direction towards the Ponds Creek.

"Near the head of the Ponds Creek is another similar old lead, and which, I believe, will become an important one.

"On the Boundary Tin Mine, a few miles further to the eastward, occurs an older basalt, of a brown and purplish colour, and much decomposed. It may possibly have some relation to the volcanic breccia underlying the Pliocene basalt in the section at Inverell, and to another similar breccia exposed in the cliff section on Newstead Creek."

Carboniferous.—Mr. Wilkinson's identification of these rocks is discussed on page 66.

Granite.—Mr. Wilkinson distinguished granites of at least two epochs, and illustrates their relative ages, and that of a "dense greenstone trap," by a sketch plan of an occurrence at Captain Swinton's station near Cope's Creek, showing euritic granite intruding, and traversing the greenstone, whilst the latter intrudes a white porphyritic granite (The "Tingha" granite). The latter is described as full of white orthoclase crystals of about an inch in length, which stand prominently out on the exposed surface of the rock. The white porphyritic granite ("Tingha") weathers into round shaped bosses, whereas the finer-grained eurite granite ("Acid") is generally broken up into angular masses.*

* Tin-bearing country, New Eng'and. Legislative Assembly Paper, 181—A, 1873, p. 6.

The chemical composition of these typical local granites is shown in the following analyses by H. P. White and W. A. Greig; and the petrological characters and hypothetical mineral constitution by G. W. Card.

Typical "Acid" Granite, Middle Creek, Tingha.

8095. A medium to coarse grained acid granite.

Orthoclase is the predominant mineral, and gives to the granite a prevailing pink colour. A lesser amount of white felspar is also present. A little biotite and patches of a yellowish alteration product occasion a speckled appearance.

Chemical Composition.

Number of Analysis—1,288–10. H. P. White.

	Weight percentage.	Molecular ratio.
Silica	76·28	1·271
Alumina	11·41	112
Ferric oxide	1·60	10
Ferrous oxide	0·72	10
Magnesia	0·15	4
Lime	0·62	11
Soda	3·97	63
Potash	4·54	48
Water (110°C.)	0·16	
Water (110°C+.)	0·40	
Carbon dioxide	0 04	
Titanium dioxide	0·20	3
Zirconium dioxide	absent	
Phosphoric anhydride	0·17	1
Sulphur trioxide	absent	
Chlorine	absent	
Fluorine	absent	
Sulphur (Ferric sulphide)	absent	
Chromium sesquioxide	absent	
Nickel and cobalt protoxides	absent	
Manganous oxide	0·06	
Baryta	absent	
Strontia	* present	
Lithia	* present	
Vanadium sesquioxide	absent	
	100·32	

The norm (hypothetical mineral constitution) is determined by Mr. Card as follows :—

Quartz	34·9
Orthoclase	26·7
Albite	33·0
Anorthite	0·3
Diopside	0·8
Akermanite	0·4
Iron ores	2·5
Apatite	0·3

3065. Typical "Tingha" Granite.

"A medium (to coarse) grained and porphyritic biotite grey granite. Variety sometimes known as adamellite.

"Under the microscope felspar largely predominates, plagioclase (oligoclase and a more basic variety) being abundant. It is but slightly clouded, and frequently shows zoning due to progressive variations in composition. A little biotite is present, and occasionally apatite.

*Spectroscopic reaction only. Gold and silver absent.

Chemical Composition.

No. of Analysis, 1,289–10. W. A. Greig.

	Weight percentage.	Molecular ratio.
Silica	71·27	1·188
Alumina	13·40	131
Ferric oxide	1·11	7
Ferrous oxide	1·89	26
Magnesia	0·79	20
Lime	2·46	45
Soda	3·08	50
Potash	4·91	52
Water (100 C.)	0·18	
Water (100 C.)	0·32	
Carbon dioxide	0 03	
Titanium dioxide	0·24	3
Zirconium dioxide	absent	
Phosphoric anhydride	0·10	1
Sulphur trioxide	absent	
Chlorine	0·06	1
Fluorine	absent	
Ferric sulphide	absent	
Chromium sesquioxide	absent	
Nickel and cobalt oxides	0·01	
Manganous oxide	0·07	
Baryta	absent	
*Strontia	present	
*Lithia	present	
Vanadium oxide	absent	
	99·92	

Neither gold nor silver present.
Specific gravity, 2·687.

The norm (hypothetical mineral constitution) determined by Mr. Card is :—

Quartz	27·6
Orthoclase	28·9
Albite	26·2
Anorthite	8·0
Diopside	5·0
Hypersthene	1·6
Magnetite	1·6
Ilmenite	0·4
Apatite	0·6

By the quantitative system it would be classed under the magmatic name "Toscanose."

As regards the trend of the early drainage in the Tingha district, Mr. Wilkinson, in 1883, wrote †:—

> "The principal Tertiary leads are Jones', Hammonds, Stannifer, Walmsley's, Brickwood, McMillans', Jealousy, Elsmore, from which large quantities of ore have been, and still are, being raised. Nearly all the leads have a westerly trend, and are covered by basalt. This basalt has been traced winding amongst the granite and slate hills, past Inverell and Auburn Vale. Near Inverell the basalt of the Cope's Creek country is connected with another flow of basalt which has come down the Macintyre Valley. The Elsmore lead is a tributary to the latter, and there is no doubt that the main channel, which has not yet been prospected, will be highly stanniferous in the vicinity of Newstead and Elsmore, seeing that the valley has been deeply eroded through the tin-bearing granites of these localities."

* Spectroscopic reaction only. † Ann. Rept. Dept. Mines for 1883, p. 151.

Geological mapping confirms the westerly trend of the buried channels; it is evident that they differed in no essential from the direction of the present streams. The early Macintyre—represented by the Elsmore Valley Deep Lead—pursued a westerly course like the present between Newstead and Inverell.

The early Cope's Creek and Darby's Branch—represented by the Topper's Mountain—Brickwood lead, and the Jenning's Deep Lead, trended westerly like their successors.

The Gilgai Deep Lead—with its north-west and then northern fall, is represented on a smaller scale by the present Pond's Creek.

The water-partings between the early streams occupy the same position as at present.

David, writing of the early drainage channels in the Vegetable Creek district, states :—

> "What was the exact configuration of the country at the time of the first outburst of the basalt lavas, geological evidence fails to tell. That part only which has been sealed up under the lava sheets has been preserved to the present day, and its shape is being gradually restored by the workings on the 'deep leads.' The results of these subterranean explorations tend to show that most of the country now covered by lava sheets, and forming, in places, main lines of water-parting, was at that time near to, or part of the principal drainage channels, and that the trend and fall of these old rivers agreed approximately with that of their nearest modern equivalents."*

As regards Mr. Wilkinson's reference to the deep leads in the vicinity of Newstead and Elsmore, geological mapping proved that the granite of this locality is apparently surrounded—partly under the basalt sheet—by metamorphic sedimentary rocks of Permo-Carboniferous (Lower Marine), or Carboniferous age of non-stanniferous character away from proximity of contact with the granite; hence the area of tin-bearing granite being very circumscribed, payable tin-leads are not likely to occur at any great distance from their source.

The persistent efforts of Mr. F. W. Penberthy and the late Mr. H. Penberthy, of Elsmore, to locate further tin-bearing channels from the Newstead-Elsmore granite mass, is deserving of better success than has of late years been achieved.

(*b*)—Tingha–Inverell Geological Map.

Description of geological sections and general geology.

No. 1.—From Inverell–Glen Innes Top road, near Elsmore, to Darby's Branch.

The direct distance between the points mentioned is about 15 miles, or 20 following the section line.

Beginning at the north end, a few chains from the Top road, a knoll of highly altered sedimentary rocks is seen rising above the enwrapping basalt sheet. These consist of quartzites and fine cherty jointed slates, forming excellent road material, for which purpose it is used wherever available. The rotted slate at contact of granite is used for brickmaking close to the Gilgai road, near Inverell.

At the Top road the section crosses diagonally a dyke of quartz-felspar-porphyry, about 2 chains wide, striking N. 15° W. through the altered rocks. Its crumbling outcrop has also been utilised for road purposes, as blinding.

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* Geol. Veg. Ck., 1887, p. 59.

The age of the sedimentary rocks*—locally known as "Trap," from the absence of fossils—has long been in doubt. C. S. Wilkinson, regarded them as "almost certainly part of the carboniferous formation of which the Rev. W. B. Clarke's report states that 'the *middle* beds of this formation—those of the Hunter and the Hawkesbury—are widely distributed on the western border of the country between New England and the interior.' "† It is clear, however, from the several reports furnished by the latter on New England, that this reference does not apply. At the early dates of these reports—1852 and 1853—Mr. Clarke included the whole stratified series between the top of the Wianamatta and the lowest coal-bearing beds of the Hunter Valley in his "great carboniferous formation of New South Wales." He, moreover, clearly defined the subdivisions, "Upper," "Middle," and "Lower"—the Wianamatta stage being designated "Upper,"‡ the Hawkesbury stage and the then undivided coal measures the "Middle;" whilst the "Lower" embraced the Permo-Carboniferous Marine beds—then also undivided—as plainly shown in the following extract :—

> "Lower beds, which are full of marine fossils of the same genera and species as those found in the lower beds of the Carboniferous formation of Ireland. The lowest members of the Carboniferous formation, as above described by zoological evidence, appear, as they ought according to this arrangement, at various parts of the Illawarra, along the Wollondilly or Burragorang, about the heads of the Colo River, and in various places along the Valley of the Hunter and its affluents."§

In the quotation given by Mr. Wilkinson, Mr. Clarke was referring to the coal-bearing Mesozoic series of the Clarence, Condamine, and Gwydir (capping the older formations), which he then included in his Carboniferous system.

Even as late as 1873, in his anniversary address to the Royal Society of New South Wales, he alluded to the "possibility of finding near Elsmore outliers of what may be considered the carboniferous beds that are found to the westward." In Appendix D, p. 51, he added—

> "The extension of coal in this direction is rendered probable by the fact that a seam of coal crosses the Macintyre about nine miles below Inverell, and is doubtless connected with the Warialda and Gragin country."

The coal seam alluded to outcrops in the river bank on Byron Station, in portions 33 and 36, parish Champagne, county Arrawatta, on the same geological horizon as the Ashford seam further north, which probably is contemporaneous with the Greta or Lower Coal Measures under the present classification, whilst the Gragin and Warialda belong to the Clarence Stage of the Mesozoic, and are probably Jurassic.

The existence of coal on Byron Station, was first reported by Leichhardt from information received, in "Notes on the Geology of parts of New South Wales and Queensland," published in Germany in 1847.‖

The jointed and highly altered sedimentary rocks of Newstead, Elsmore, and the neighbourhood evidently came under Mr. Clarke's "Metamorphic" division, which he regarded as "not newer than Devonian, and probably not

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* These notes were written before palæontological evidence was obtained of the true age of these strata. It is, however, considered advisable to retain this discussion. † Mines and Mineral Statistics, N. S. Wales, 1875, p. 80. ‡ Report No. IX, 24th June, 1853, Gold Discovery Papers, vol. 3, p. 10. § Report No. 1 6th Nov., 1852, *op. cit.*, vol. II, p. 27. ‖ Translated by G. H. F. Ulrich, and republished in the Australian Almanac, 1868, p. 32.

older than Silurian," where exposed near Bingara and Warialda. Writing of the geological structure of the western slopes of the highlands of New England, between the summits of the Cordillera and the interior, in the basins of the Gwydir and Macintyre Rivers, Mr. Clarke concluded that—

> "The geological formations of which the present area is composed consist of various granites, porphyries, serpentine, and ordinary trappean products, metamorphic and unchanged slates, quartzites, and limestones, a series of carboniferous deposits, identical with that of the Hunter and Wollondilly basins, and alluvial deposits derived from the preceding."*

A recent investigator—L. A. Cotton—regards the older sedimentary rocks of the Elsmore–Tingha district as lithogically similar to the Ordovician rocks of Berridale and Tallong, though more metamorphosed.†

Later evidence has probably determined them to be not older than Lower Permo-Carboniferous or Carboniferous at the oldest; though it is possible that the cleavable slates of Swanbrook Creek, at the southern foot of the Sugarloaf Trigonometrical Station, Parish of Swanvale, County Gough, about six miles north-east of Elsmore, may prove of Silurian age.

It is interesting to note that the symmetrical cone of the Sugarloaf rising above the olivine basalt plateau consists of *tinguaite*. G. W. Card examined the specimens, and furnished the following notes :—

> "The rock from the Sugarloaf, Newstead North, is either phonolite or tinguaite. (These grade into one another, phonolite being the lava and tinguaite a fine-grained intrusion. This is probably best classed as tinguaite.)"
>
> From its mode of occurrence, the Sugarloaf tinguaite is probably a plug or pipe.

7823. Tinguaite.

The Sugarloaf, Newstead North.

"A dull green, jointed rock, splitting in a rudely platy manner. Slightly greasy appearance along planes of parting. Nepheline can occasionally be detected with the lens.

Under the microscope, micro-porphyritic crystals of nepheline are sparsely scattered through an obscure ground mass of orthoclase, felspar-soda-pyroxene, &c., with felted microlites. Nepheline shows rectangular and hexagonal sections and is in part clear, in part clouded with alteration products. Soda-pyroxene is inconspicuous. Iron ores occur in small quantity."

Attention might also be here drawn to another most perfectly symmetrical cone—Gragin Peak—in portion 25, Parish Myalla, County Burnett, which forms such a conspicuous feature in the landscape from the neighbourhood of Delungra and Warialda. This peak rises at a steep angle for 300 or 350 feet above the basalt plateau forming its base, and about 700 feet above Reedy Creek. It, like the plateau, consists of olivine-dolerite; but towards the summit exposes compact black layers, which Mr. Card regards as volcanic tuffs, altered by contact with the dolerite. It may be provisionally regarded as a volcanic plug.

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* Report No. VIII, 7th May, 1853, *op. cit.*, vol. II, p. 343.

† Proc. Linn. Soc. N. S. Wales, XXXIV, pt. 4, 1909, p. 738.

The following petrological notes have been supplied by Mr. Card :—

Gragin Peak.

" Olivine-dolerite.

7,891, 7,892, 7,895. A coarse-grained dolerite, the three essential constituents—plagioclase, augite, and olivine, being distinctly recognisable. It breaks with a very uneven fracture, and weathers to a light yellow. Under the microscope, all the constituents are clear and unaltered. Structure sub-ophitic.

Augite.—Brown to purple in colour, quite fresh ; more or less automorphic, sometimes twinned. Colour zoning is sometimes distinct, and occasionally there is a grouping of abundant inclusions centrally.

Felspar.—A basic *labradorite.* Lath-shaped: quite fresh; well-twinned (the striation is readily noticeable in hand specimens).

Olivine.—Fresh, but for a little discoloration in places. Abundant.

Magnetite.—Crystals scattered plentifully throughout.

One of the specimens (7,896) is finer-grained than the above. 7,894 is another type, being not only finer-grained but shows a somewhat different structure, and is devoid of olivine."

The Rev. W. B. Clarke, referring to this peak under the name of Carajin, in 1853 described it as " the most elegant and graceful hill of the kind I have anywhere seen. It takes its name from its representing " a tall fellow."*

Recently the Writer obtained a suite of marine fossils from Parish Bowman, County Gough, about three-quarters of a mile south-west of the Pinnacle, near junction of Rocky Creek and the Beardy River, about eleven miles north-north-westerly from the previous discoveries by Professor David, at Swamp Oak Creek, Parish Arvid. They occur in impure limestone and calcareous mudstone, immediately under a thick bed of coarse conglomerate. Sufficient forms were identifiable to enable W. S. Dun to definitely assign them to *Permo-Carboniferous*, probably to the lowest division—the Lower Marine Beds. Following are his determinations :—

Fenestella, 2 spp.—one of which is very like *F. fossula*, the other may be compared to *Hemitrypa hexangula*, Lonsdale.

Brachiopoda—Productus brachythœrus, G. Sby.
Martiniopsis subradiata (small).
" *oviformis*, McCoy.
Spirifera duodecimcostata.
" cf. *vespertilio.*
" cf. *Clarkei*, De Kon.
Dielasma (?).

Pelecypoda—Aviculopecten cf. *squamuliferus*, Morr.
Deltopecten subquinquelineatus, McCoy.
Chœnomya (?).

Crinoid stems—ossicles—very large, may belong to *Phialocrinus.*

" The age of these beds is undoubtedly Permo-Carboniferous, but it is at present impossible to say definitely whether they are Upper or Lower Marine, though I am inclined to think there is a general indication of their representing an imperfect Lower Marine Fauna. It is pointed out that the Drake beds are almost certainly Lower Marine."

* Gold Discovery Papers, vol. 2, p. 348.

The palæozoic sedimentaries in the Vegetable Creek district, about 30 miles north-easterly from Inverell, have been described by David (who regards them as identical with those of the Tingha–Inverell area) in the following terms :—

"These strata consist of olive-green clay shales passing into dark blue and black claystones with bands of leaden-grey felspathic quartzite, and beds of greenish-brown conglomerate, siliceous grit, and quartzite. Area, 34 square miles; thickness, at least 5,000 feet.

"By far the greater part of this formation is composed of beds of clay shale and claystone.

"In the vicinity of the crystalline rocks the colour of the Silurian strata is bluish-brown to indigo, but at a distance of 2 to 3 miles from the igneous rocks the colour changes to a greenish or rusty-brown.

"The bands of felspathic-quartzite are from 3 to 4 inches in thickness, and occur at intervals of from 1 to 2 feet, the intervening rock being claystone.

"In places, the clay shales are much blackened by carbonaceous matter, which is seen under the microscope to have become altered into graphite in places, and where the carbonaceous claystones have come in contact with igneous rocks, and become silicated, a hard lydian stone has been formed, as to the north of Bailey's Mine, in portion 20, parish of Hamilton.

"In texture these rocks vary from a fine compact stone to pea-grits and coarse conglomerates.

"The conglomerates are formed of well-rolled pebbles of quartzite, claystone, and occasionally quartz, set in a base of felspathic-quartzite or sandy-clay shale. The size of the pebbles varies from $\frac{1}{2}$ inch to 6 inches. The coarsest conglomerate noticed by me was on Stony Creek, in portion 180, Parish of Scone.

"The disintegration of these pebble-conglomerates give rise to small surface accumulations of gravel, which in the neighbourhood of these conglomerates are apt to be mistaken by the miner for Tertiary gravel. He should therefore be on his guard to distinguish these derived Silurian pebbles from the true Tertiary, as the former are not usually an indication of stream tin, whereas the latter generally are.*

"In the vicinity of the crystalline rocks nearly all traces of the original bedding in the claystones has been effaced, and the rock has been cleaved by a series of cross joints running 20° north of east and south of west, and 20° west of north and east of south, causing the stone, when disintegrated, to split up into angular cubical blocks.

"In such altered areas indication of the original stratification is given in places by the beds of pebble-conglomerate and chert. The laminæ of the chert beds are very thin, over 100 being present in a thickness of 2 inches.

"The average strike of these rocks is 35° east of north and west of south, and the prevailing dip appears to be westerly, but there is evidence of the beds having been folded over, so that the direction of the dip is frequently reversed.

"The amount of dip varies from 17° to an angle of 90°, the average inclination from the horizontal being 50°. As a rule the dip is steeper as the claystones approach the crystalline rocks, and gentler as they recede from them.

* The only fossils obtained from these rocks occur just beneath the conglomerate horizon, associated with grits and limy rocks. Further west the altered sedimentaries are extensively developed, without the special strata mentioned. Probably these must be assigned to the Carboniferous period.

"Fossils were found by me in these rocks only at three places :—

"1. Near the south-east corner of portion 7, parish of Arvid. The strata here are fine bluish-brown sandy claystones, in beds from 2 to 3 feet thick, separated by layers of bluish-black clay shale from 1 inch to 6 inches thick. The last show black stains, due to obscure plant remains.

"2. In the bed of Stony Creek, in portion 30, parish of Arvid, a bed of compact grey quartzite shows faint impressions of bryozoa, and stems of stone lilies.

"3. At a point about 50 chains west 10° south from the north-west corner of portion 136, parish of Arvid, is a pale blue siliceous grit with rusty cavities showing casts of bryozoa, small lamellibranchs and univalves, and a few joints of stems of stone lilies. The fossiliferous bed is a few feet only in thickness. These fossils prove the beds to be of marine origin, but do not afford conclusive evidence as to their age."*

In August, 1910, the Writer visited the fossiliferous locality marked on David's geological map, and was enabled to pick up the fossil horizon readily from the complete identity of the strata with those near the Pinnacle, near Rocky Creek. From the site marked in Portion 29, Parish Arvid, County Gough, in the bed of a small eastern tributary of Swamp Oak Creek, the Writer obtained a number of fossils, amongst which Mr. Dun was able to identify the following forms :—

Protoretepora.
Fenestella fossula, Lonsdale.
Stenopora c.f. gimpiensis, Eth. fil and Nich.
Crinoid stem ossicles.
Spirifera c.f. tasmaniensis, Morris.
Chonetes.
Productus (?).
Ptychomphalina.
Loxonema (?).
Conularia lævigata, McCoy.

These, like the previous collection, are regarded by Mr. Dun as Permo-Carboniferous with Lower Marine affinities.

It is not improbable that the Ashford limestone, in Quarry Reserve 344, Parish Macintyre, County Arrawatta, about 12 miles north-west of the village of Ashford, and 23 miles west of the Pinnacle fossiliferous outcrop, is of Carboniferous age.† The limestone occurs in altered clay-stones, and quartzites, in close contiguity to intrusive granite; and in consequence of the latter is converted into a highly crystalline white, grey, and dove-coloured marble, varying in texture from coarse to fine grained and compact. Its remarkable purity is shown in the following analyses :—

	(959)		(960)
Carbonate of calcium ($CaCO_3$)	99·64	.....	99·21
Ferric oxide and alumina ($Fe_2O_3 + Al_2O_3$)	0·18	.....	0·28
Insoluble in acids	0·10	.....	0·28
Undetermined	0·08	.....	0·23
	100·00	.....	100·00

* Geol. Veg. Ck., 1887, pp. 53-4.

† The Writer recently obtained a few fossils from the limestone which may throw some light on the subject.

The age of the stanniferous granites of Vegetable Creek district, which are doubtless identical with those of Tingha, was regarded by David as Permian, because of their probable co-relation with the granite intruding Permo-Carboniferous strata at the Ashford coal-mine, and the absence of any granitic intrusion in New South Wales Triassic rocks.*

The granitic intrusion of Permo-Carboniferous strata in New South Wales was first identified by E. F. Pittman, at Undercliff, near Wilson's Downfall† (where a coal seam has been converted into an impure graphite by the intrusion), and has since been emphasised by E. C. Andrews, who independently noted the same phenomenon.‡

In view of the aforegoing evidence, the granites of the tin districts may be regarded as late Permian or early Mesozoic.

Continuing the section—About 15 chains from the Top road the edge of the basalt sheet is met, and about 90 feet below the level of the road masses of fossiliferous concretionary ironstone mark a persistent horizon, probably of swamp or lake origin. The deposition of the iron oxide doubtless resulted from the chemical action of the abundant plants of this stage, whose imprints and fruits are finely preserved. The age of the intercalated ferruginous muds between lava sheets had been determined as Lower Miocene, and correlated with tin-bearing drifts between Cope's and Middle Creeks, by C. S. Wilkinson :—

> "The identification of the older Tertiary drifts, clays, and ironstones as of lower Miocene age rests on their perfect lithological resemblance to certain leaf beds of that age in Victoria, and also on the fossil leaves and plant stems which have been found in the ironstones between Newstead and Elsmore."§

These plants were subsequently worked out by Baron von Ettingshausen, who regarded them as of Eocene age.‖

R. Etheridge, junior, in "Stratigraphic Notes" on localities mentioned by Ettingshausen, states :—

> "At Newstead, near Elsmore, and on the Macintyre River, near Inverell, plant remains and seeds, accompanied by freshwater shells, occur in a concretionary ironstone, apparently an earthy limonite, overlaid by basalt."

The species are the following¶ :—

> *Piper Feistmanteli ; Myrica Koninckı ; Alnus Maccoyi ; Quercus Darwini ; Fagus Benthami ; Artocarpidium Gregoryi ; Cinnamomum Leichhardtii ; Diemenia speciosa ; Aralia elsmoreana ; Elæocarpus Muelleri ; Acer subintegrilobum ; Acer subproductum ; Malpighiastrum Babbagei ; Sapindus Gossei ; Carpolithes amaranthaceus ; Carpolithes pygeoides ; Carpolithes Morisoniæformis ; Carpolithes Wetherillioides.*

From the Elsmore Valley No. 1 Shaft the Writer, in 1898, collected Tertiary leaves from under basalt, which were identified by W. S. Dun, as follows :—

> *Cinnamomum* (*?*).
> *Piper* cf. *Feistmanteli*, Ett.
> *Fagus* cf. *Hookeri*, Ett.
> *Artocarpidium Gregoryi*, Ett.**

* *Op. cit.*, p. 48. † Records Geol. Survey N. S. Wales, 1896, V, pp. 26-30. ‡ *Op. cit.*, VIII, pt. I, 1905, p. 110. § Mines and Mineral Statistics, 1875, p. 87. ‖ Memoirs Geol. Survey N. S. Wales, Pal. No. 2, 1888. ¶ *Ibid.*, p. 188. ** Ann. Rept. Dept. Mines, 1898, p. 189.

And from Smith and Little's tunnel under basalt, in Portion 183, Parish Clive, County Gough :—

Podocarpus præcupressina, Ett.
Pesudopinus Wilkinsoni, Ett. (very abundant).
Phyllocladus asplenoides, Ett.
Bambusites arthrostylinus, Ett.

E. C. Whittell, Inspector of Mines, collected from the same shaft :—

Malpighiastrum Babbagei, Ett.
Cinnamomum Leichhardti, Ett.
Apocynophyllum Kingi, Ett.
Myrsine Stokesi, Ett. (?).*

In addition to several of the above forms, W. S. Dun has identified the following amongst specimens collected by L. A. Cotton† :—

Cinnamomum c.f. polymorphoides } Elsmore.
Eucalyptus (?) Ettingshausen }

Banksia myricæfolia, Ett. }
Eucalyptus diemenii, Ett. }
Ficus (?) } Elsmore Valley Deep Lead.
Ficus Phillipsi, Ett. }
Dryandra præformosa, Ett. }

The section continues over basalt and basalt soil for about 1 mile, when the sedimentaries are again encountered. Near the junction of the latter it is probable that the extension of the post-basaltic channel or basin forming the north-western lead from Elsmore Hill is concealed.

This channel was traced north-westerly from the slope of the granite in Portion 52, Parish Anderson, crossing the Newstead-road about 7 chains west of the south-west corner of Portion 246. where the bed of the lead was reached at 190 feet. The late Mr. H. Penberthy, of Elsmore, informed the Writer that here the wash was 14 feet thick, and yield 28 lb. of tin ore to the load, a total of 40 tons being obtained.

About 5 chains further north-north-west the lead was bottomed at 225 feet, with very little tin. The wash was reported to have reached a thickness of 30 feet, but the little tin present was confined to the last 4 feet. About 8 cwt. sold from this shaft.

The lead was then traced north-west for about 10 chains, the depth below surface remaining at 225 feet. Eastward from the upper portion of the lead—in portion 94—a series of bores have recently been put down, on behalf of Mr. H. Penberthy, in search of another gutter; these bottomed on altered sedimentaries at from 160 to 202 feet without wash. The lead continued south-westerly for about 9 chains to the back of the present Post Office. A shaft 3 chains south from this point bottomed at 150 feet, showing a steep fall from the nearest point of Elsmore Hill, and a tributary to the north-west lead. The latter then took a north-west course in the direction of the probable outlet referred to, the nearest shaft, near the west boundary of portion 28, being about 28 chains (?) from the section line. Its depth is reported to have been 225 feet.

From the poppet-head shaft about half a ton of tin only was obtained, nor was any payable tin obtained in the furthest shaft, which is not hopeful for

* Ann. Rept. Dept. Mines for 1897, p. 200. † Proc. Linn. Soc. N. S. Wales, XXXIV, pt. 4., 1909, p. 740.

the continuation of this channel. This lead, in common with the Elsmore Valley lead, is characterised by a great thickness of pipeclays overlying the drift, and by lignite.

Contrary to superficial evidence, this lead is not covered with basalt, hence is later than the latest flow, an age corroborated by boulders of decomposed basalt in the wash. The great thickness of lignitic material and fine clays indicates conditions of quiet sedimentation in a basin or dammed stream channel.

For 73 chains the section continues over altered sedimentaries to the edge of the basalt sheet covering the original Elsmore Deep Valley. Superficial basalt soil covers a little of the sedimentaries on this line, but is too insignificant to be noted or mapped.

Where the line crosses the Elsmore–Inverell road another quartz-porphyry dyke is encountered, outcropping very lightly—in boulders—for a short distance.

Close to the edge of the Elsmore Valley basalt, an incline shaft was sunk during the mining "boom" of 1906–7, to a depth of 310 feet, in a fruitless endeavour to reach a supposed by-wash from the old deep channel worked as "Elsmore Deep Lead," about twelve chains distant. For the same purpose three drill bores were recently put down in the first 7 chains from the incline shaft, the depths being 60 feet, 94 feet, and 153 feet, as they receded from the metamorphic rock into the basalt-filled valley. The 94 feet bottomed on the former without drift. The 153 feet passed through the basalt at 118 feet, then 2 feet of clay, followed by 3 feet of drift with traces of tin; it was continued to 153 feet in clayey material which may have been rotted bed-rock.

The valley is here confined between low ridges of metamorphic rock to a width of about 25 chains.

The section crosses it diagonally to intersect the Elsmore Deep Lead at No. 2 shaft, and therefore shows a correspondingly greater width.

At its source on the western fall of Elsmore Hill this lead is known as "Penberthy's," after the discoverers.

For some distance it followed a southerly course between the granite and the metamorphic rocks; passing shortly beneath the basalt sheet, which enwrapped the older formations and buried the previous drainage system. Its course then changed to north-west as proved in the Elsmore Valley deep shafts. Its position near the first, and most western of these, was previously located by a drill bore in M.L. 20, in 1895; the bed of the lead being reached at 205 feet 6 inches from surface. At 187 feet, a 10 feet bed of sand drift was pierced immediately beneath the basalt, carrying an unworkable percentage of tin. At 210 feet 6 inches, three feet of wash, resting directly on the bed rock, proved exceedingly rich. The tin oxide was mostly coarse and well-rounded; but being cemented in part necessitated battery treatment. The rounded pebbles of tinstone in this cement presented the appearance of plums in a pudding.

As bearing on subsequent efforts to prove the further extension of the lead to the westward by boring, it is important to record the narrow escape from missing the channel in the successful bore. Subsequent workings from No. 1 shaft established the fact that the drill reached the lead within 1 foot of a large granite boulder resting directly on the bed rock, hence if the drill had been a couple of feet in that direction from the site selected no tin would have been obtained, and as the lead only averaged about 40 feet in width at this point, if another bore had been put down it is certain that it would have been outside the channel, for the shaft subsequently sunk south-westerly

from the bore reached the bed rock in 155 feet, and after being continued in it for other 70 feet, a level north-easterly reached the lower lead in a distance of 76 feet.

This lead when being worked was described by J. B. Jaquet as trending N. 53° W., and falling north; thickness of wash 1 to 3 feet. At the time of inspection it had been proved for a length of 500 feet.*

The principal workings lay between the two shafts, and extended for about 25 chains or more. The upper drift sand was reached by a rise from No. 1 shaft, but was not worked.

At the present time the most urgent question bears on the possible further extension of the lead westwards. Unfortunately no information is now obtainable of the late company's operations in that direction from the No. 1, or West, Shaft. The Writer was, however, informed by a miner who was engaged at the west end of the workings, that the provings extended about 300 feet from the intersecting level from the shaft. At 200 feet a "bar" was met where the channel narrowed to about 25 feet. The level was continued 100 feet below the bar on a westerly-dipping bottom; at the face the wash was about 3 feet thick, but carried very little tin; its level, moreover, was about 5 feet below the drift level at the bar.

No further proving was attempted from the existing workings; but drilling was resorted to about 34 chains westerly. Beginning in an old bywash of the Macintyre River, three bores were put down about 4 chains apart. About 30 chains north-westerly from this line other bores were put down from the northern side of the valley. Unfortunately records are not available, but the results evidently were not encouraging, for efforts ceased.

The first three bores near the river are locally reported to have bottomed at 170, 211, and 280 feet; but the figures are largely conjectural. The depth of the latter indicates a deep gutter, but, as the bedrock consists of rotted slates, the drill may have passed into these without encountering channel filling.

At a later date Mr. F. W. Penberthy furnished figures from the late company's books, viz., No. 1, 134 feet; No. 2, 129 feet; No. 3, 173 feet 6 inches; No. 4, 248 feet; No. 5, 164 feet 6 inches; No. 6, 147 feet; but regarded the numbers wrongly placed.

The narrowness of the proved channel below No. 1 shaft renders it very liable to be missed where bores are drilled 264 feet apart.

Whilst not sanguine of extreme extension of tin transport—in payable proportion—from its very limited source at Elsmore Hill, there is still hope of further development in this lead, which, so far, has only been traced for about a mile from its source.

The coarseness of the tinstone pebbles, and their well-worn character, moreover, appear to indicate further transport of finer and lighter particles. It is, therefore, desirable that more systematic effort should be made to trace this deep channel westward from No. 1 shaft.

The section crosses the Macintyre River at the foot of a ridge of metamorphic sedimentary rocks (Permo-Carboniferous) already described, which rises to an elevation of about 270 feet above it. (The river at this point is about 1,820 feet above sea-level, and is used in this description as a base for recorded heights along the section.)

From the top of the ridge there is a gradual fall of 180 feet to Stockyard Flat. The line from the river intersecting 83 chains of metamorphic rocks, a small superficial tongue of basalt, and a quartz-porphyry dyke.

* Ann. Rept. Dept. Mines for 1897, pp. 175-6.

Stockyard Flat, where basalt is again encountered, at first sight conveys an impression of a possible western outlet of a channel beneath the basalt, from the south-western slope of the Newstead stanniferous granite boss, in the direction of Boney Gully; but closer investigation favours a corresponding northerly trend to that of the present drainage through Swamp Gully to the Macintyre. This, if followed, leads under the river beneath the south-western margin of the Elsmore granite and the ridge of metamorphic rocks just referred to, and junctions with the Elsmore Deep Lead.

On the geological map it will be noticed that the outlet of this tributary into the early Macintyre (Elsmore Valley Deep Lead) is confined to a very narrow strip at the junction of the granite and metamorphic rocks at Swamp Gully, in the vicinity of the New Cornwall tin lode. A shaft has been sunk in this narrow basalt tongue, but the bedrock outcrops at the junction of the gully with the river.

The present Stockyard Flat is narrowed by two outcrops of metamorphic rock on its southern side, but as the basalt extends for a width of 60 chains at a higher level, an early channel may lie south of the present.

Metamorphic rocks are again encountered south of Stockyard Flat, forming a rough, stony ridge extending south-eastward for over 2½ miles without a break, and having an elevation of 430 feet above the river at the point of intersection. Hence the early drainage of the contiguous granite, south of the ridge, may have been, in part at least, north-west as far as portion 204, parish Anderson, and thence north into Stockyard Flat, or Boney Gully.

On the line of section through the metamorphic ridge last referred to, another quartz-porphyry dyke is crossed, striking N. 5° W., with a width of about half a chain.

Beyond the metamorphic, basalt is again met. A tributary of Gilgi Creek has cut its channel along the junction of the two formations, its level being about 180 feet above the crossing of the Macintyre.

Basalt extends along the section for 95 chains, reaching an elevation of 460 feet above the latter; at its termination granite, of the acid type, is encountered about 60 feet lower. From this point to the end of the section, granite persists as the surface rock, save where superficially cloaked by remnants of a basalt flow, at Red Hill (Armidale Road), Topper's Mountain Lead, Jennings' Lead, and Red Hill (between Cope's Creek and Darby's Branch). Probably it correlates with the lower lava sheet beneath the fossiliferous ironstone of Newstead and Elsmore, or may be still older. Wherever the older basalt forms the surface between Cope's Creek and Middle Creek it is represented by abundant concretionary ironstone (frequently agglutinated in masses of some extent), by deep red soil and loose ironstone pebbles. Decomposition has usually penetrated to considerable depths, as revealed in shaft sinking.

The concretionary ironstone masses are bauxitic, and clearly derived from decomposition of the basalt. They constitute the so called "bauxites," but, so far as investigation has proceeded, are too low in free alumina to be commercially considered "bauxites." Whether their appearance is due to original composition of the basalt, or is a simple product of decay under special conditions, is not determinable.

H. I. Jensen, D.Sc., states that basalt soils may—

> "In certain situations be reduced by leaching to the condition of clays composed of iron oxide and alumina (laterite and bauxite clays), and rather deficient in plant food. This would be particularly the case on a naturally well-drained basaltic plateau, when the basalt is rich in alkali and the rainfall is good. Then the dense scrub vegetation extracts the

potash as fast as it is liberated ; carbonic acid and ammonia, generated by decomposing vegetation and other organic matter, sink into the subsoil, and leach out of it the lime and silica respectively. The soda likewise filters away in solution."*

Throughout the area lying between Cope's Creek and Middle Creek, and at Red Hill, on the Inverell–Armidale road, masses of concretionary or pisolitic iron oxide mark the site of the older lava flow. From the fact of its weathering into the above, and the remarkable absence of influence on the flora (which does not differ specifically from that of the granite), it is probable that there was radical difference in composition between the earlier and later lava flows.

Several representative samples were submitted to partial analysis ; one from between Ponds Creek and Stannifer yielded 14·70 per cent. of free alumina ; another, from near Stannifer–Tingha Road, yielded 22·47 per cent. ; and yet another, from Byron Station, yielded 27·56 per cent., with 20·02 per cent. of iron, and 8·12 per cent. of silica.†

The close specific identity of the flora of the older basalt and the granite areas is in marked contrast to that of the newer. Whilst the predominantly *Eucalyptus albens*, *E. meliodora*, *E. viminalis*, and *Angophora intermedia* flora of the latter affords a ready and reliable guide to the boundary between it and the granite, with its equally characteristic species, viz., *E. eugenoides*, *E. macrorhyncha*, *E. de albata*, *E. Stuartiana*, *E. Andrewsi*, *E. sideroxylon*, *Calytris*, &c., and general scrubby undergrowths, the flora of the older basalt lends no help. Beyond, perhaps, more luxuriant growth in the rich red soils of the latter, there is, as before stated, practically no specific botanic differentiation between the prevailing flora of the older basalt and the granite.

In parts, where denudation has reduced the original higher granite bounds to valley levels, the resultant granitic waste has so overspread and cloaked the basalt, filling the latter, as to completely conceal it, and to render identification and mapping almost entirely dependent on shaft-sinking.

Fifty-five chains south-westerly from the edge of the basalt the section cuts the Stannifer–Bischoff dam in the main eastern branch of Boney Gully, which was constructed many years ago in connection with a battery for the Stannifer–Bischoff lode near by. The dam is now held as a registered water right, and utilised for a little perfunctory ground-sluicing in Boney Gully by the lessee.

About 65 chains southerly a small remnant of the older basalt sheet is reached at Red Hill, close to the Inverell–Armidale road, the highest points on either side of the road being 580 and 590 feet above the river crossing. Masses of concretionary iron oxide and red aluminous soil alone remain to represent the original lava-flow. Under the south bump, drift occurs, as proved by tunnels and a shaft, the thickness of the basalt residue overlying the drift being about 20 to 60 feet. Shafts under the South Nob reached drift in 10 feet with little tin.

The stanniferous alluvial of Sheep Station Flat heads under Red Hill, and junctions with Middle Creek at Lower Stannifer. This once-important lead probably derived its re-concentrated tin contents from the waste of the older lead represented by the remnant of drift under Red Hill.

A large portion of this flat was taken up in 1887 under the name of Wheal Victoria. A smelting plant was erected near by at Top Stannifer ; but, judging from the slag dump, little smelting was done.

* Proc. Linn. Soc. N. S. Wales, 1909, XXXIV, pt. 4, No. 136, pp. 719, 720. † The masses of volcanic agglomerate and coarse tuffs in the vicinity of Inverell probably mark proximity of points of eruption.

From Red Hill the section passes to Topper's Mountain, crossing Middle Creek in 95 chains, and reaching the top of the mountain in 105, the height of the latter points being 440 and 910 feet above the Macintyre, the Mountain constituting the greatest elevation within the bounds of the map—about 2,720 feet above sea level.

Middle Creek is being extensively dredged lower down about Stannifer, but nearer the mountain becomes rock-bound and unproductive.

Topper's Mountain is an "Acid" granite dome of no great extent, falling rapidly north-east and south-west. On its western fall several tin lodes have been discovered, viz., Long's Lode, Lock's Big Lode, Jackson's Lode, Mannix's Lode, and Cain's Lode.

From the summit the section runs nearly east for 115 chains. At 38 chains the edge of Topper's Mountain basalt sheet is reached. It is necessary to point out that the name of the mountain is applied locally to the upper, or north-eastern, extension of an adjacent basalt sheet covering tin leads, which extends for over 5 miles south-westerly to the end of the Brickwood Lead, and is very probably connected with the flow trending west and north-west to Gilgai and beyond.

The general fall of the drainage beneath the Topper's Mountain basalt, as pointed out by C. S. Wilkinson,* and confirmed by the Writer, is south westerly.

Twenty-five chains from the western margin of the basalt the section cuts the Stannifer Freehold Deep Shaft (locally known as the Brisbane) in Portion 229, Parish Herbert, County Gough. Early prospectors about 1882 were beaten by water at a depth of 120 feet. The present company reached stanniferous wash at a depth of 154 feet, or about 675 feet above the level of the Macintyre River, where the section crosses.

Continuing eastward for 50 chains, the Morgan Tin Syndicate's shaft is reached, about 20 chains within the eastern margin of the basalt. Here the drift was reached in 100 feet from the surface.

The line then makes an acute angle south-west to Taylor's or Borthistles' shaft, distant about 30 chains, where wash was reached at 150 feet. Thence 20 chains south-south-west to the south-east corner of portion 419; thence along its southern boundary 13 chains to the recently-bottomed Humphry's shaft, where the lower end of Schumann's branch lead was cut at 142 feet. From this point the section follows the lead south-easterly through Schumann's workings to Orchard's, and thence about 10 chains to the south-eastern edge of the basalt. Through Schumann's—the principal discovery of its time—the wash level rises from 142 feet at Humphry's to 130 feet from surface in the top shaft, and from 110 feet to 90 feet in Orchard's workings.

Between the edge of the Topper's Mountain basalt and that of the Jennings Deep Lead a width of 64 chains of granite intervenes, the base of the former being 170 feet above the base of the latter; the highest point of the intervening granite being 200 feet above the base of the basalt in the Jennings No. 1 shaft in M. L. 346, Parish Swinton, County Hardinge.

The deepest channel under the Topper's Mountain basalt—the Brisbane, or Stannifer Freehold—lies at an elevation of about 20 feet above the Jennings Deep Lead.

An interesting feature in the latter is the remarkable manner in which the viscid lava partially enwrapped and moulded granite boulders lying in the old stream bed. This lead has also a south-west fall.

* Ann. Rept. Dept. Mines for 1883, p. 151.

Twenty chains from Jennings' No. 1 shaft, Billin's shaft, in Mineral Lease 318, is cut near the southern edge of the basalt, which here was pierced in 63 feet.

The junction of the "Acid" and "Tingha" granites occurs beneath the basalt sheet at Jennings' Lead.

After crossing a narrow strip of Tingha granite, the small tongue of basalt known as "Budden's Hill" is reached on the north bank of Stony Creek, a tributary of Cope's Creek. The basalt here is but 30 to 40 feet thick. The creek divides a portion of it, locally known as "Hungry Hill." Drift occurs beneath the basalt, and has been followed extensively by tunnelling.

From Stony Creek the section runs east-south-east for 105 chains to Cope's Creek, the bed of which lies 420 feet above the Macintyre. This portion of Cope's Creek is known as Albion Flat, which has recently been acquired for dredging purposes by the Melbourne Cope's Creek Tin Dredging Company. Higher up the channel becomes rock-bottomed.

75 chains south east from Cope's Creek Red Hill is reached, consisting of a small patch of basalt overlying stanniferous drift, in area about 135 acres, which has been extensively worked by both tunnelling and shafts. The summit of Red Hill has an elevation of 740 feet above the Macintyre.

The section re-enters the acid granite 15 chains S.W. of Red Hill, and then runs direct S.S.E. to Darby's South Branch, 110 chains from Red Hill. Between the two Smoky Mountain granite ridge has an elevation of 680 feet above the river, and 220 feet above Darby's Branch, towards which it falls steeply.

At the crossing of the latter a dredge was installed for a brief period. From Darby's Branch there are no special features of interest to intersect, hence the section is not continued to the southern boundary of the map.

No. 2.—*Geological Section from Topper's Mountain basalt to north of Gilgai.*

Starting from Humphry's shaft, at Topper's Mountain, a section was run for the purpose of endeavouring to connect the Topper's Mountain basalt flow with that of Gilgai.

It is necessary to emphasise the fact that in so doing it is not sought to show direct connection between the underlying channels, or "leads," of these distant points; but that the same lava flow filled and overwhelmed them.

The vertical sections of shafts along the line reveal great diversity of levels in the various channels crossed.

In endeavouring to trace the basalt flow the section was run from shaft to shaft, without which it would have been impossible to locate it in many parts of the level areas, owing to the cloaking of granite detritus; and the absence of any botanical distinction in the flora.

From a study of the leads worked under the basalt in this district, it is clear that the past and present drainage were practically in the same direction.

As the section nears Gilgai the Brissett, or Gilgai, deep lead is followed, and its probable outlet traced northerly towards Inverell.

Humphry's shaft was bottomed in November, 1909, at a depth of 142 feet on rotten granite dipping to the west; at 30 feet in the direction of the dip, from 12 to 18 inches of tin-bearing wash was reached, evidently in the northern extension of Schumann's Branch lead.

From this shaft the section runs south-westerly to the Brickwood Extended deep lead in portion 171, parish Swinton, country Hardinge; passing through Sandy Flat, where the difficulty of identification of the basalt is intensified.

It is necessary to impress the fact recorded on the map that boundaries in this locality are only approximate; the cloaking of granite detritus referred to prevents definite divisions being attempted. No two field workers would be able to run the same boundaries, save where outcrops of solid rock appear.

The boundaries adopted are based largely on those sketched by Wilkinson and David, with such alterations and additions as later workings have revealed. The divisions between the granite and metamorphic rocks and the newer basalt of the Macintyre Valley have been, however, considerably modified, and may be accepted as correct.

At 50, 80, and 87 chains along the section from Humphry's, shafts have been sunk in soil and decomposed basalt to 90 and 100 feet without bottoming according to local report.

Eleven chains further Woods and Whites' shaft reached bottom at 135 feet near the south boundary of M.L. 207, parish Herbert, county Gough. Forty feet of decomposed basalt—concretionary ironstone in part—followed by 90 feet of bouldery basalt, constituted the overburden at this point. Johnson's shaft—about 10 chains further—bottomed at 130 feet under similar conditions. Some rich patches of tin-wash were obtained from these shafts. Forty-two chains further Lock and Curry's shaft in portion 201, parish Swinton, county Hardinge, bottomed at 118 feet on granite dipping steeply south, with a few water-worn pebbles but no wash.

Thirty-eight chains further the Brickwood Extended deep shafts are reached in P.M.L. 3. Here bottom was reached at 150 feet, through 15 feet of basalt soil, 109 feet of hard basalt, 8 feet of lignitic clay, 16 feet of coarse sandy drift—without tin—and 2 feet of coarse water-worn wash, with coarse water-worn tin ore, on to soft granite bed rock.

The bottom of this lead is about 75 feet lower than the bedrock in Humphry's Shaft at Topper's Mountain.

The southern boundary of this portion is locally known as the "Potato Ground," because of the large unabraded blocks of pure cassiterite found in the soil. (See also Butchart's and Partridge's Lodes.) In October, 1909, about 3 tons of such blocks were obtained, the largest weighing from 20 to 150 lb. of practically pure tin oxide.

From the Brickwood Extended Shafts the main extension of the basalt is still south-westerly, covering the Brickwood Lead, which was profitably worked in Portions 4, 208, 209, and 176, Parish Swinton, County Hardinge. (Brickwood Farm.)

The basalt terminates on the eastern boundary of portion 400 in the same parish. The denuded edge of this old deep lead fed the present Irwin's or Chain of Ponds Gully, which falls into Cope's Creek.

From Brickwood Extended Shaft the section runs to Hobbs' Shaft on west boundary of Portion 268, where bottom was reached at 110 feet through basalt. Though basalt continues in this direction, as shown on the map, it is evident from the higher bedrock under the lead that the drainage was towards the deeper Brickwood lead.

Forty-eight chains from Hobbs' Shaft the Victoria Lead, in M.L. 88, parish Swinton, is intersected, where 80 feet sinking through decomposed basalt reached bedrock about 25 feet higher than that of Brickwood Extended.

Thirty-seven chains from the last station a small boss of granite rises above the surrounding basalt.

From here the section turns due north to intersect McMillan's Lead, with its overburden of 50 feet of decomposed basalt and ironstone; the bedrock here being about 20 feet higher than that under the Victoria Lead.

McMillan's lead was fairly rich, and was worked for some distance.

From where the section cuts the lead to Beckett's Lead is 87 chains. An interesting feature of the latter is the occurrence of two basalt flows separated by about 10 feet of sand and drift containing so much "black sand" with the tin as to be designated the "Black Lead."

The upper basalt has a thickness of about 23 feet, including surface soil derived from it; the lower sheet is from 7 to 8 feet thick, and rests on the main tin-bearing lead containing about 3 feet of sand and wash; yielding about 50 lb. of tin ore to the load in the lower portion.

Fifty-six chains from Beckett's the section cuts a small, but conspicuous, mass of bauxitic concretionary iron ore.

Basalt forms the surface for 60 chains further, then granite for 24, when basalt again intervenes. Thirty-five chains from its margin, the "Oaks" Lead is reached, where the depth of sinking is 30 feet through basalt soil and ironstone.

From the Oaks to the United Deep Lead, in M.L. 549, parish Clive, is 94 chains. Here the sinking is through 25 feet of basalt and ironstone soil, then through 100 feet of decomposed basalt to 5 ft. 6 in. of stanniferous drift resting on granite bedrock. A considerable volume of water was met in this lead, which is probably part of the Gilgai Deep Lead System. Though granite is shown in the section as intervening, it does not necessarily imply a bar of high rock; the channel may lie between or around one or other of the small granite outcrops on the section line.

The level of the bedrock at the United Deep Lead is about 135 feet higher than the bedrock in Brissett's Shaft in the Gilgai Deep Lead.

Thirty-seven chains from the United Shafts is Wetzler's Shaft in Portion 608, Parish Clive, which bottomed on hard granite at 148 feet, being the deepest of several in the vicinity. Sinking here was through 40 feet of basalt soil and concretionary ironstone, 88 feet of decomposed basalt, 16 feet of sandy drift, and 4 feet of wash dirt (averaging 30 lb. of tin ore per load), resting on granite bedrock. Water was here also too heavy for other than steam power.

Fifty chains further the Bundarra–Inverell road is reached, which the section follows for 47 chains to a shaft in Portion 157, at the 22-mile road peg. Two small outcrops of granite are crossed, but, as before stated, the United Lead may pass between or alongside them.

The shaft near the road, in portion 15, is reported to have bottomed at 90 feet through basalt, but no work evidently was done below the latter, at least no particulars are obtainable.

Twenty-eight chains westerly Hammond's Shafts, in the same portion, are reached; these bottomed at 104 feet.

From Hammond's to Brissett's is 32 chains, but the section was deviated slightly to intersect a small outcrop of granite about 10 chains from and in the same portion as the latter, for the purpose of showing the steep fall to the Gilgai Deep Lead in Portion 177, Parish Clive, close to the village of Gilgai.

For a number of years persistent efforts have been made, under aid from the Prospecting Vote, to prove this portion of the lead, which here trends northerly towards Inverell, after receiving tributaries from the south and south-east.

John Brissett and others, under agreement with the owner of this land (Mrs. Marsh), having sunk a shaft (east) through 95 feet of basalt on to

granite bedrock, dipping steeply south-west, continued in the latter for 38 feet, then drove 180 feet in the direction of the dip, at 80 feet the basalt came down to the top of the drive; at 180 feet the dip was too steep to follow.

A bore was then put down 420 feet west from the end of the drive which bottomed on granite in 101 feet. A shaft was then started 171 feet from the bore in the direction of the drive, aid being granted to water-level and 30 feet below it.

The basalt was pierced at 169 feet, and the bedrock reached at 176 feet. Seven feet of drift sand overlaid the bedrock, with a few boulders on the latter, which dipped east.

At 182 feet a drive was put out south for 65 feet through boulders and drift sand, a little tin occurring on the bottom only. At the face the wash dipped off to the south and the level was lost.

At 186 feet in the shaft an eastern drive was put out for 113 feet; the level was lost at 53 feet. The bedrock is reported to be rising below the face of this drive. Midway between the face and the lost level at 53 feet, bedrock was reached in a monkey shaft at 8 feet below the level. It is reported that fair prospects were obtained at this point, but at the date of the Writer's inspection in August, 1909, the water in this level was dammed back from the shaft to allow of lower level prospecting; hence a prospect was not obtainable.

The shaft was then deepened to 202 feet, a plat cut, and a drive started north in hard granite; further aid was allowed for 75 feet of driving in the bedrock in this direction.

Water made at the rate of 3,000 gallons per hour; a 6-inch Cornish lift pump being employed.

A further 25 feet of driving was allowed, the drive being eventually extended 150 feet. Fifteen feet from the face a rise was put up 6 feet, but a few pebbles only were obtained on the bedrock.

Operations in the lower level then ceased, and attention was again given to the south drive at the 182 feet level. On the drift being again opened a report arose that rich wash had been struck, giving the impression that it had been struck in the north drive.

The southern provings were advanced about 10 feet beyond the earlier extension, and another level driven about 34 feet south-east from the former. The southern face was rising, but the south-east was still dipping; the former apparently skirting the side of the channel.

It is hard to see why, when the shaft was deepened, the lower level was not carried under the southern drive, or between it and the eastern, where the channel had been proved, instead of driving north in hard rock at great expense to cut the channel in another quarter, at most but 100 feet from its intersection in the east drive. It was, moreover, noticeable when the lower drive was being driven that it was entirely in hard aplitic granite, distinct from the coarse-grained rock under the channel.

Granites of the fine-grained character exhibited in the north drive are usually more resistant than the coarser-grained, and are noticeable as "bars" in the beds of granite streams; hence this distinction between the bedrock and western country pierced in the lower level should have conveyed a warning of higher bank or bar in that direction.

At the end of the expensive northern level the proving was no further advanced than it was in May, 1908.

The channel is well-defined, and from the amount of drift sand and the large granite boulders on the bottom, it was evidently a stream of some

magnitude. An attempt should be made to systematically test the value of the wash. So far as exposed in the later southern workings, the tin is confined to a thin streak on the bedrock at intervals—which, whilst rich in itself would average very low. Richer patches, however, may occur along the course of the channel which should be driven on.

On the value of this portion of the lead will depend the prospects of development of this old channel towards Inverell. Though not proved directly, it is evident that the outlet is to the north along the probable course indicated on the geological map.

Near the S.E. corner of Portion 1½, Parish Clive, Staghly's bore was put down to a reported depth of 200 feet in basalt without bottoming. About 46 chains south from the bore a shaft was sunk in portion 344, to a reported depth of 130 feet without penetrating the basalt. Unfortunately no particulars are available of these tests, nor of other bores further north—one 70 chains north in Portion 309, Parish Clive, is reported 130 feet deep, yet unbottomed.

A narrow isthmus of basalt along Sheep Station Gully, connecting the Gilgai and Inverell basalt areas marks the northern extension of the Gilgai Lead.

The bottom of the 200 feet drill bore is 180 feet lower than the bedrock level in Brissett's shaft, and, as reported, still in basalt.

No. 3.—*Geological Section, from Auburn Vale Road, N.W. corner portion* 9, *Parish Auburn Vale, to Scott and Grey's lead portion* 312, *Parish Clive, County Gough.*

Beginning at the western end, the section starts in a small patch of metamorphic Permo-Carboniferous rock on the Auburn Vale road, and in a few chains reaches the granite, and in eight the edge of the small outlier of basalt known as Barnes' Hill, in Portions 161 and 184, Parish Auburn Vale, the probable thickness of the cover being about 100 feet. It forms a noticeable peak on the Pine Ridge granite range, which in parts contains a network of thin quartz veins with tin, as at the Cliff Mine, in portion 7 on the north, where a little molybdenite also occurs. South-westerly about 45 chains is the Leviathan tin lode, worked by the Auburn Vale Tin-mining Company. Here tin ore occurs in quartz veins and greisen, associated with copper and arsenic below the cap.

For 47 chains granite persists, when another small outlier of basalt caps the granite in Portions 10 and 201, Parish Clive. Under its lower edge cemented sand outcrops, and continues to form the surface along the section for 22 chains. On the opposite side of Sheep Station Gully it again outcrops under the basalt in portion 402. It resembles the sand drift overlying the wash in the Gilgai lead at Brissett's, but has been silicated into a hard rock, forming a superficial covering to the granite where denudation has removed the basalt. It probably represents high-level drainage. Its presence first disclosed the possibility of an outlet in this direction for the Gilgai lead, before the presence of Staghly's deep drill bore in Portion 1½ had been discovered. The width of the deep channel basalt filling would thus be about 10 chains, as shown in section.

Disregarding the slight break in the basalt on the east of the bore, where cemented sand outcrops, the extreme width of the basalt east and west is about 60 chains. Five chains from the eastern edge a windmill shaft pierces the basalt for 50 feet near the Inverell-Gilgai road. Between it and the road cemented sand ("grey billy") again outcrops, showing a fairly steep dip of the bedrock to the westward.

For 40 chains east the section runs across a rough granite ridge, rising about 100 feet above the road. From this point the section deviates south-easterly to cut Scott and Grey's lead in portion 312, finishing at the south-east corner.

Scott and Grey's lead was discovered about 1900 by the holders named, who have been working continuously since. Sinking is through about 30 feet of rotten basalt, the deepest shaft being 40 feet. No connected run or gutter has been traced, the appearance being—like others in the Tingha district—rather in the form of disconnected pond-like basins.

In places, 14 feet of sand overlays the bedrock.

A section of the last shaft sunk prior to inspection in August, 1909, gave the following measurements :—

6 to 7 feet—Red loamy soil.
4 to 5 feet—Soft rotten basalt.
14 feet—Sand.
3 to 18 inches—Wash.
Granite bedrock.

A special feature in the wash is the occurrence of large water-worn blocks of crystalline quartz, the largest of which, by admeasurement, weighed about 1 ton. Quite a number of these occur in the workings, and have been left underground.

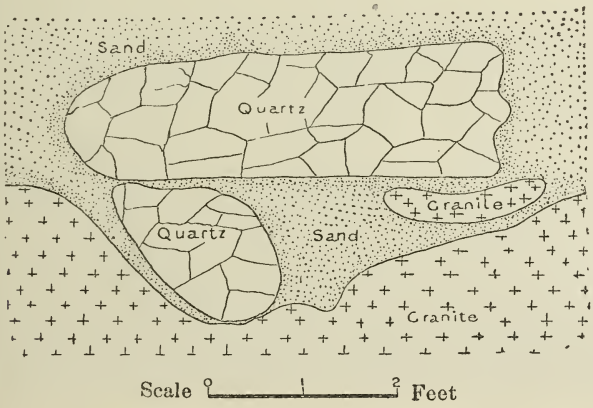


Fig. 3.—Large quartz boulders, Scott and Grey's Claim, Gilgai.

The section ends at the south-eastern corner of portion 312, against granite.

The idea was locally entertained by some that this mine was on an extension of the Gilgai Deep Lead—was, in fact, the outlet. Careful barometric readings, however, place Scott and Grey's channel bottom 152 feet higher than that of the former in Brissett's deep shaft.

It is highly probable that the shallower channel was a tributary of the deeper.

(*c*)—Wilson's Downfall.

Description of the rock formations in the Wilson's Downfall and Maryland Tin-field (County of Buller).

By E. C. Saint-Smith, Field Assistant.

The section with the map of the Wilson's Downfall and Maryland Tin-field accompanying this work commences at the summit of Sugarloaf

Mountain, on the border of New South Wales and Queensland, and maintains a general north-west direction across Baker's Hill, Maryland, to the Queensland border again on portion 57, Parish Maryland, a distance approximately 14 miles. The highest altitude shown is Sugarloaf Mountain—3,750 feet, and the lowest—the bed of Ruby Creek, on water reserve 857A, Parish Ruby—3,060 feet above sea-level, respectively (according to aneroid readings).

The summit of Sugarloaf Mountain is composed of a coarse-grained granite which occupies the major portion of the area geologically mapped. This rock varies considerably throughout the area, it being decidedly acidic in character at this spot, but becoming gradually more basic when traced in a northerly direction. This rock produces soils of every colour from light yellow to red, according as it is acidic or basic in composition. Several veins of greisen occur through the rock mass—especially at the head of Herding Yard Creek and its tributaries on the Queensland border. These veins usually carry tinstone, wolfram, and a little molybdenite, with occasional coatings of iron and copper pyrites along joint faces. At Amosfield, near the Maryland-road turn off from the Stanthorpe-road, a typical sample of this rock has been described by G. W. Card, in the following terms :—

[8127.] Amosfield.—Maryland road.

"A very coarse porphyritic granite, with phenocrysts of cream-coloured orthoclase.

Biotite in moderate quantity.

Copper pyrites was noted coating a joint face."

A carefully-averaged sample of this rock taken over a considerable area yielded the following chemical composition :—

Analysis (1,459–10) by H. P. White.	Percentage composition.	Molecular ratio.
Silica	67·24	1·121
Alumina	14·20	139
Ferric oxide	1·50	9
Ferrous oxide	2·88	40
Magnesia	1·39	35
Lime	3·24	57
Soda	3·98	65
Potash	4·07	43
Water (110° C)	0·12	
Water (110° C+)	0·50	
Carbon dioxide	0·06	
Titanium dioxide	0·65	8
Zirconium dioxide	absent	
Phosphoric anhydride	0·11	1
Sulphur trioxide	absent	
Chlorine	*trace	
Fluorine	absent	
Chromium sesquioxide	absent	
Nickel and cobalt oxides	absent	
Manganous oxide	0·06	
Baryta	0·07	
Strontia	†present	
Lithia	†present	
Vanadium sesquioxide	absent	
Copper oxide	.....	
Sulphur (Ferric sulphide)	absent	
	100·07	

Specific gravity, 2·711. No gold or silver present.

* Less than 0·01 per cent. † Spectroscopic reactions only.

PLATE VI.

E. C. Saint-Smith.

Sugarloaf Mountain from Wilson's Downfall.

Calculating from this the norm is obtained.

Quartz	19·44
Orthoclase	23·91
Albite	34·06
Anorthite	8·62
Diopside	3·03
Hypersthene	7·12
Magnetite	1·86
Ilmenite	0·15
Apatite	0·34

Another sample from Wilson's Downfall Mr. Card refers to as :—

[7860.] Porphyritic Biotite-Granite.

"Under the microscope the felspar is seen to include so much oligoclase as to bring the granite into the adamellite division of some authors. In addition to biotite and hornblende, sphene, zircon, and apatite are present as accessories. The rock is quite fresh."

A short distance down from the summit of Sugarloaf mountain an entirely different variety of granite makes its appearance. This rock—which is seen to intrude the coarse granite above referred to, is an acid granite persistently fine-grained in texture, and always exhibits sparsely scattered tiny flakes of biotite. Upon decomposition it yields an abundance of light-coloured sand, and will hereafter be referred to as the sandy granite. This rock is characterised by a very stunted and generally useless flora, prominent amongst which may be mentioned the dogwood scrub (*Jacksonia scoparia*) and honeysuckle (*Banksia*), the former being especially troublesome to stock-owners, as it is thought by them to produce the disease known as ricketts in cattle in this district. Between Sugarloaf Mountain and the head of Wylie Creek, the sandy granite is traversed by numerous small veins of quartz with wolfram and tinstone—the principal vein opened being Stalling's wolfram lode. The intrusion of the coarse granite by this rock is well seen in the bed of the Herding Yard Creek, in portion 61, parish of Ruby. Several circular formations of granitic quartz, averaging 2 feet in diameter, occur through the rock mass. The tin occurring in the area occupied by this granite is, characterised by (*a*) absence of black sand, (*b*) high purity, and (*c*) ruby colour, as compared with the abundant black sand, *e.g.*, Wylie Creek, and the black colour of the tin obtained from areas within the boundaries of the coarse granite. Two samples of this rock have been examined by Mr. Card, who reports as follows :—

[8123.] "Sandy" Granite.

"Parish Ruby, county Buller.

A pinkish gray granite weathering red, grain-size medium. Sub-porphyritic, with comparatively large crystals of white orthoclase. Biotite occurs sparsely disseminated as small flakes, and in inconspicuous nests."

A carefully averaged sample of this rock, taken over a considerable area, yielded the following :—

Chemical Composition.

Analysis (1,460-10) by W. A. Greig.

	Percentage composition.	Molecular ratio.
Silica	76·52	1·275
Alumina	12·73	125
Ferric oxide	0·48	3
Ferrous oxide	0·62	8
Magnesia	0·14	3

Chemical Composition—*continued.*

	Percentage composition.	Molecular ratio.
Lime	0·75	13
Soda	3·58	58
Potash	4·59	49
Water (100° C.)	0·17	
Water (100° C. ×)	0·37	
Carbon dioxide	0·04	
Titanium dioxide	0·07	
Zirconium dioxide	absent	
Phosphoric anhydride	0·02	
Sulphur trioxide	absent	
Chlorine	*trace	
Fluorine	absent	
Chromium sesquioxide	absent	
Nickel and cobalt oxides	absent	
Manganous oxide	0·12	
Baryta	absent	
Strontia	†present	
Lithia	†present	
Vanadium sesquioxide	absent	
Copper oxide	*trace	
Sulphur (ferric sulphide)	.....	
	100·20	

Calculating from this, the norm is obtained :—

Quartz	36·42
Orthoclase	27·24
Albite	30·39
Anorthite	3·61
Corundum	0·51
Hypersthene	0 96
Magnetite	0·70

[7853.] Aplitic Granite.

Portion 3, Parish Ruby, County Buller.

"A pink, rather fine-grained rock, showing a very little biotite, in addition to quartz and felspar.

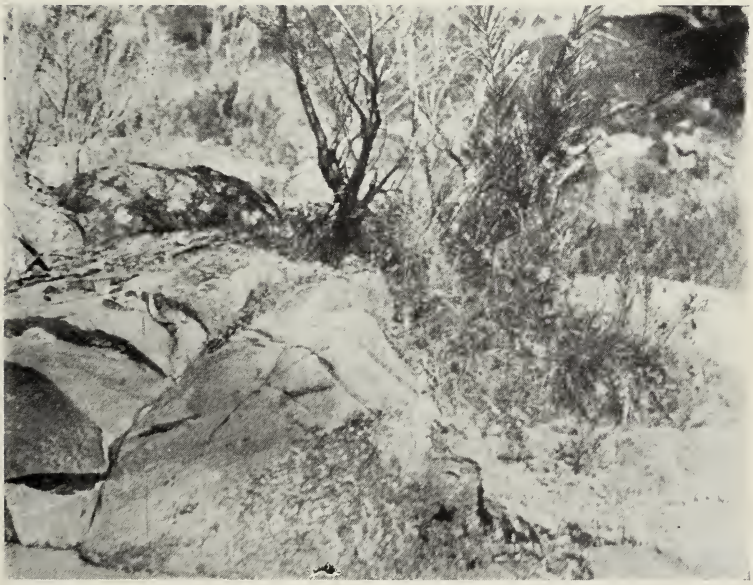
Under the microscope, a good proportion of oligoclase is seen. Some of the felspar shows micro-perthitic structure, and may be microcline."

The area extending from the head of Herding Yard Creek in a north-west direction to near the Maryland-road turn off from the Stanthorpe-road, a distance of about 2 miles, is occupied by coarse granite, on the central portion of which an extensive area of stanniferous alluvial has been worked along Herding Yard Creek and its tributaries—Hannon's, Sloper's, and Blackwall Gullies.

From near the north-west corner of Portion 57, Parish of Ruby, north-west to Portion 62, and from Portion 53 west to the Stanthorpe-road crossing, on the Queensland border, occurs a considerable area of sandy granite—roughly half the parish. The western portion of this rock mass is traversed by several streams which have been worked for alluvial tin, notable among which may be mentioned Ruby Creek, and its tributaries—Ward's (or Mossman's), Dickson's, Lincolnshire, and New Zealand Gullies. The sandy nature of the

* Less than 0.01 per cent. † Spectroscopic reactions only.

PLATE VII.



E. C. Saint-Smith.

Intrusion of "Coarse" Granite by the "Sandy" Granite, Herding Yard Creek, Amosfield.

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soil arising from the decay of this rock is well seen along the Stanthorpe-road, and also along Sandy Creek. Along the middle portion of the course of Lincolnshire Gully (south of the Stanthorpe-road), numerous veins of greisen, with tinstone, have been found, whilst $1\frac{3}{4}$ miles north-west of this occurrence Cosgrove's Wolfram lode (quartz) has been worked. An immense number of graphic granite and pegmatite veins are found through the sandy granite, especially close to its periphery, whilst long thin tongues—almost felsitic in texture—intrude the coarse granite. These structures are remarkably well developed along Herding Yard Creek, between the Herding Yard Bucket Dredge, on M.C.P. 37 to 48, and the Falls, on Portion 52, Parish of Ruby. In the north-west portion of this intrusive mass, on W.R. 857A, Parish of Ruby, the boundary between the "sandy" and "coarse" granites is extremely difficult to define, tongues and small bays of the former jutting out into the "coarse" granite in all directions, the difficulty being accentuated from the fact that the "coarse" granite is much more acidic here than in the neighbourhood of Wilson's Downfall, Liston, and Amosfield. Except in the form of aplitic dykes, the sandy granite is not seen again within the area mapped.

From the centre of Portion 62 to the northern boundary of Portion 452, Parish of Ruby, the coarse granite again makes its appearance; it is here marked by an increased acidity and a very great number of aplite bars—some of which can be seen to belong to the sandy granite mass, whilst not a few appear to be a phase of differentiation in the cooling of the coarse granite magma itself.

At the north-east corner of Portion 62 occurs a low hill, composed of augitic diorite, which Mr. Card describes as follows :—

[7901.] Diorite (Augitic).

North-east corner, portion 62, Parish Ruby, County Buller, 6 miles north west of Wilson's Downfall.

> "Under the microscope, made up of about equal proportions of rather dusky plagioclase and pale green hornblende. The presence of residual pyroxene indicates that part at least of the hornblende is secondary. A little magnetite."

This rock presents considerable differences in structure, passing from mica diorite, quartz diorite, grano-diorite, to a hornblende granite. It produces a distinctly red to black soil of good quality. An excellent illustration of the variations shown by this rock is to be seen in the bed of the Herding Yard Creek, on Portions 52, 53, and Special Lease 05–7, Parish of Ruby, where, in the bed of the stream it is a mica-lamprophyre, but when followed in an easterly direction up a low ridge, it becomes progressively more acidic and coarser in texture. Occasional small isolated patches of this rock are found in the area mapped, e.g., near north-east corner of Portion 63, near north-east corner of Portion 52, Parish of Ruby, &c.; in all cases they can be clearly seen to be older than the surrounding granites, being intruded by the latter, and also by a network of aplitic granite veins, pegmatites, and graphic granites, a remarkable example being visible in the bed of the Herding Yard Creek, near the east boundary of Portion 53. The following descriptions have been furnished by Mr. Card on typical specimens of this rock secured from different portions of the mass.

[7861.] Mica-Lamprophyre (Minette).

Bed of Herding Yard Creek, 4 miles north-west of Wilson's Downfall. (Sp. L. 05/7, Parish Ruby, County Buller.)

"[7861.] A microcrystalline, glistening gray rock, breaking with an uneven fracture. Some patches of quartz present.

Under the microscope, orthoclase predominates, the other constituents being biotite, hornblende, augite and apatite. A little plagioclase is probably also present. The orthoclase shows zoning."

[7811.] Quartz-Diorite.

Bed of Herding Yard Creek, Liston; portion 52, Parish Ruby, County Buller.

"Fine grained.

Under the microscope, made up of approximately equal amounts of dark and light coloured constituents. Consists essentially of felspar and hornblende, with quartz, biotite, and magnetite as accessories, and veins of secondary epidote. The felspar is much clouded, but seems to be almost entirely plagioclase."

[7809.] Grano-Diorite.

Liston, portion 52, Parish Ruby, County Buller.

"Under the microscope, coloured constituents (biotite and hornblende) make up nearly one-half the rock. Quartz is subordinate, and plagioclase greatly exceeds orthoclase. Sphene, magnetite, pyrite, and apatite are accessories."

[7870.] Grano-Diorite.

Herding Yard Creek, near north-east corner portion 52, Parish Ruby, County Buller.

"Under the microscope, dark and light coloured constituents are about equal in proportion.

Of the felspar a rather basic plagioclase is strongly dominant over orthoclase. Quartz is subordinate.

Hornblende and biotite present, the former in excess of the latter. As accessories, sphene, apatite, and magnetite. Apatite is locally abundant and occurs as conspicuous long needles."

[7866.] Hornblende-Granite.

Near Herding Yard Creek, Parish Ruby.

"Under the microscope, the predominating mineral is felspar, and the ratio of plagioclase to orthoclase is so high as to bring the rock under the grano-diorite class. The felspar is in part cloudy. Quartz is subordinate.

Hornblende and biotite in considerable quantity, the former predominating. As accessories, sphene and apatite both occur as conspicuous crystals, and in comparative abundance."

From the diorite hill at the north-east corner of Portion 62 referred to, the section line follows the general north-west direction, crossing a width of about 70 chains of coarse granite to Ruby Creek, on the west side of which stream the rock commences to assume a more porphyritic character and on the east portion of C.L. 4861 presents a remarkable facies—being

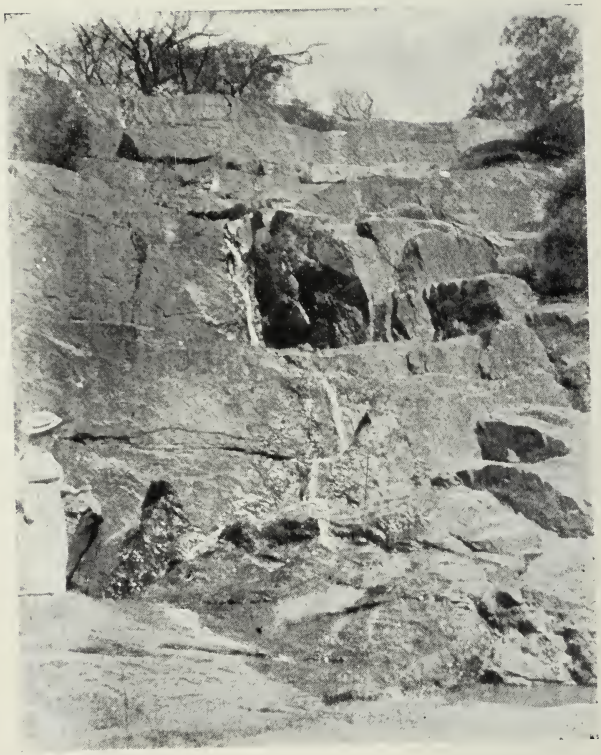
E. C. Saint-Smith.

Porphyritic Granite, showing large basic segregation, Herding Yard Creek, Amosfield.

E. C. Saint-Smith.

Diorite Dyke intruding Porphyritic Granite, Herding Yard Creek, Amosfield.

PLATE IX.



E. C. Saint-Smith.

Herding Yard Falls, Herding Yard Creek, Amosfield.

Showing Porphyritic Crystals of Felspar
in Porphyritic Granite.

characterised by huge porphyritic crystals of pink orthoclase felspar, with abundant hornblende and megascopic sphene. The passage from the normal coarse granite into the porphyritic variety is very gradual, and odd quite unaltered large crystals of felspar, identical with those seen in the porphyritic portion, are to be found for considerable distances into the normal rock. A noteworthy feature of this rock is the number and size of the basic segregations occurring in it—one such segregation being shown in the accompanying photograph at the bottom right-hand corner.

Porphyritic variety of the coarse granite showing large basic segregation, Portion 53, Parish Ruby, County Buller.

In Herding Yard Creek especially this rock is traversed by numerous veins of aplite, graphic granite, and pegmatite, an interesting feature of their occurrence being the fact that they are lying quite horizontal in many instances, and are frequently so thin as to look like lace spread over the rock. In several cases it is highly probable that these veins represent the final stages of differentiation in the rock magma itself rather than intrusions, Excellent examples are visible in Special Lease 05–7 ; also in Portion 51. Parish Ruby, where veins of opaline quartz are seen traversing the granite at the falls. The pegmatite veins can in places be observed to gradually pass out into typical aplites. The veins of greisen which occur in both the coarse granite and the sandy granite are apparently absent in the case of the porphyritic variety of the first-named rock. The coarse granite contains isolated patches of the porphyritic variety, but the felspars are distinctly lighter in colour than the characteristic pink felspars of the latter variety. The sphene crystals become progressively larger and more abundant in a northerly and north-easterly direction, being especially well developed on M.L. 327, Parish Wylie. In the case of the coarse granite the sphene is present in at least equal quantity as in the porphyritic variety, but the crystals are for the most part microscopic. Little or no botanical difference is noticeable in connection with these two varieties of apparently the one rock mass, whilst the chemical analyses agree to a remarkable extent. Coarse fragments of felspar characterise the soil produced from the porphyritic variety, the corresponding fragments being much smaller in soils resulting from the decomposition of the normal type. Small faultings, with a displacement ranging from an inch to one foot, occur in the granite masses and graphic granite, &c., veins along Herding Yard Creek. No tin or other metal of commercial value has yet been discovered actually in the porphyritic variety or in the veins traversing it. A long narrow bar of aplite, accompanied by pegmatitic and graphic granite structures, occurs near the south-east corner of C.L. 4,861, Parish Ruby, crossing the Maryland-road on the ridge above the Ruby Creek crossing. This bar presents a prominent bluff-like outcrop, having resisted weathering better than the intruded porphyritic granite.

A more detailed description of these granites has already been published (Andrews, E. C., and Mingaye, J. C. H.).*

[8,126.] Herding Yard Creek.

Mr. Card's description of the porphyritic variety of the coarse granite is herewith :—

"A highly porphyritic granite, with conspicuous crystals of pink orthoclase. Ground mass of creamy felspar, quartz, and ferro-magnesian minerals. Hornblende and biotite."

* Rec. Geol. Survey N. S. Wales, 1907, VIII, pt. 3, pp. 196–238.

A carefully averaged sample of this rock, taken over a considerable area yielded the following :—

Chemical Composition.

Analysis (1,458–10) by W. A. Greig.

	Percentage composition.	Molecular ratio.
Silica	68·25	1·137
Alumina	14·41	140
Ferric oxide	2·00	13
Ferrous oxide	2·07	29
Magnesia	1·08	27
Lime	3·06	54
Soda	3·19	52
Potash	4·74	50
Water (100° C.)	0·19	
Water (100° C. +)	0·35	
Carbon dioxide	0·05	
Titanium dioxide	0·36	4
Zirconium dioxide	absent	
Phosphoric anhydride	0·15	1
Sulphur trioxide	absent	
Chlorine	absent	
Fluorine	absent	
Chromium sesquioxide	absent	
Nickel and cobalt oxides	*traces	
Manganous oxide	0·16	
Baryta	0·03	
Strontia	†present	
Lithia	†present	
Vanadium sesquioxide	absent	
Copper oxide	0·01	
Sulphur (ferric sulphide)	.....	
	100·10	

Specific gravity, 2·698. No gold or silver present.

Calculating from this, the norm obtained by Mr. Card is :—

	Per cent.
Quartz	23·40
Orthoclase	27·80
Albite	27·25
Anorthite	10·56
Diopside	2·77
Hypersthene	3·75
Magnetite	2·09
Ilmenite	·61
Apatite	·34

The porphyritic character of the granite persists for a distance of about 45 chains along the line of section, gradually becoming finer-grained towards the periphery. The normal character of the rock then makes its appearance, but is quickly replaced by granulite, which occupies the area known locally as the Wallaroo Hills. The intrusion of the granulite by the coarse granite is well seen in the bed of the Maryland River, in Portion 461, Parish Maryland. This rock has been subjected to intense compression with the production of well marked lines of cleavage. From its appearance and resultant soil the rock might easily be mistaken for a sedimentary one, but microscope investigation determines it to be of undoubtedly igneous origin.

* Less than 0·01 per cent. † Spectroscopic reactions only.

PLATE X.

E. C. Saint-Smith.

Maryland Station, near Homestead.

Showing park-like country produced by the " Maryland " Granite (in the distance).

Partial recrystallisation of the rock material subsequent to the crushing can be seen under the microscope. The granulite here occupies the area extending from the north boundary of Portion 452, Parish Ruby, to Tompkins' Gully, a distance of approximately 60 chains.

On the northern side of Tompkins' Gully the diorite again makes its appearance, being intruded by both the coarse granite and the Maryland granite, and in turn apparently intruding the granulite. This rock occupies an area rudely circular in shape, extending from Tompkins' Gully across the Maryland River to near the south-east portion of the Village of Maryland, with the high peak of Baker's Hill (3,500 feet above sea-level) forming the centre. The boundaries of this rock are mostly cloaked, with the exception of a very small patch of rock in the bed of the Maryland River, in Portion 266, Parish Maryland, where the diorite can be seen to be intruded by the Maryland granite. The diorite produces here a good red soil. Small veins of granite and quartz can be seen intruding the rock in places on the west fall of Baker's Hill.

From a point opposite the south-west corner of Portion 14 on the Maryland River the section traverses a biotite granite. This rock has been designated the Maryland granite, owing to its development within the area mapped being represented by a relatively small semi-circular area, commencing at Maryland Homestead, and extending for a distance of about $1\frac{3}{4}$ miles in an easterly direction from it. Mr. Card classifies this granite as a biotite granite of the adamellite variety. It intrudes the diorite in the Baker's Hill locality, and appears to be itself intruded by the coarse granite on portion 24. It is a fine to medium grained greyish blue rock, with abundant quartz and mica and produces good grazing country. Small basic segregations are common : these frequently weather out with the production of small potholes, this structure being readily observed along the bed of the Maryland River in the village of Maryland. It is marked by rounded bouldery outcrops with a tendency to form tors. On Portion 24 this rock is intruded by thin veins of aplite and graphic granite with numerous small pegmatite veins. Its junction with the surrounding rocks is cloaked for the most part. The soil produced is buff to grey in colour. The area is about $2\frac{1}{2}$ square miles. The Maryland granite is characterised by a rather distinctive flora, apple-tree, grey gum, and white gum being among the commonest representatives, whilst the outcrop is marked by an abundance of a reddish yellow fungoid growth which apparently displays a preference for this rock, being rarely seen on other rocks in this district. The rock mass preserves a fairly constant facies. No mineral deposits have yet been found genetically connected with this granite, The quartz usually weathers into relief, exhibiting a low honeycombed structure. In addition to the localities above mentioned, the Maryland granite is found in very small isolated patches adjoining the Maryland-road, $\frac{3}{4}$ mile from the Two-mile Creek road crossing.

From the village of Maryland westwards and northwards the Granulite again makes its appearance and occupies the whole of the area forming the headwaters of the Maryland River, and its tributary the Ram's Swamp. Granulite is here remarkably like a quartzite, and careful microscope examination was necessary to establish its igneous origin. In places the rock is decidedly schistose in structure, and in the quarry situated close to the south-west corner of Portion 64, Parish Maryland, it presents all the appearance of a bedded rock, much folding and crumpling with minor faultings having taken place.

A large dyke of diorite intrudes the granulite on Sections 19 and 20 of the Village of Maryland. This rock is referred to by Mr. Card in the following terms:—

"No. 4" Diorite.

Maryland Common, Parish Maryland, County Buller.

"Under the microscope, made up of hornblende and plagioclase, the former slightly predominating. A little biotite and magnetite. The hornblende is all pale green in colour, and seems as if it might be in large part secondary. Shreds of hornblende are abundant as inclusions in felspar."

This dyke appears to belong to the latest phase of intrusion in the district, similar dykes being seen to intrude the granites along Herding Yard Creek, Wylie Creek, Wilson's Downfall to Tenterfield-road, the Bookookoorara River, &c. A sample taken from a dyke in the last-mentioned locality is described by Mr. Card as follows:—

[7872.] Mica-Lamprophyre (Minette).

Bookookoorara River.

"A fine-grained gray rock, breaking with a sub-even fracture. Under the microscope the constituents seen are orthoclase, plagioclase, hornblende, biotite, augite, and considerable quartz. Most of the minerals show a tendency to automorphism—that is to assume their characteristic crystalline forms."

From the middle of portion 62, Parish of Maryland, to the Queensland border—a distance of approximately $1\frac{3}{4}$ miles, the granulite gives place to coarse granite of a slightly more acidic type than the normal rock. The granite is here overlain by—

(*a*) A small area of recent stanniferous alluvial near the head of Mother Fred's Swamp; and—

(*b*) By an area of older (Pleistocene?) gravels about half a mile in width by $1\frac{1}{4}$ miles in length along and adjacent to the boundary between New South Wales and Queensland, being mostly within Portion 57, Parish Maryland. This area is slightly stanniferous, and also carries small quantities of alluvial gold, though no serious attempt appears to have been made to exploit it, owing doubtlessly to the absence of water for sluicing purposes. The gravel is usually very coarse waterworn quartz, and is more or less cemented on the surface by oxide of iron. The greatest thickness recorded to date is stated to be 18 feet.

A small area of similar age is to be seen near the north-east corner of Portion 215, Parish Maryland, between the former and the present Maryland to Warwick-roads on the Queensland border.

Still another limited area of probably similar age occurs between the Queensland border, and New Zealand Gully. This area has been successfully worked for tin, and extends across the border into Queensland for a few chains.

VIII.—TIN-MINING IN NEW SOUTH WALES.

Vegetable Creek Lead (Recent).—Tin ore was discovered in the Vegetable Creek or Emmaville district, according to David, by Thomas Carlean, in March, 1872, the site being within the area subsequently known as the Great Britain mine,* or Tent Hill, according to G. H. Gower.†

* Geol. Veg. Ck., 1887, p. 4. † Ann. Rept. Dept. Mines for 1875, p. 108.

VEGETABLE CREEK TIN MINES.

A Sketch shewing the aggregate yield of ore from each Mine, from the commencement of mining operations in the year 1872 to 31st December 1876.

NOTES For Mining purposes there are 1 16 horse power Steam Engine, 2 Steam puddling machines, and 20 Dams erected: 27 Puddling machines and 16 Sluices
525 men and 89 horses are employed on the Mines, on daily wages at Vegetable Ck
The daily rates of wages for men are 8/, 8/, 7/6, 7/, 7/- 6/8
" " " " " for mechanics from 9/ to 13/
" " " " " for Lads & Boys " 1/8 to 6/-
Tribute Parties are paid from £25 to £32 per ton of clean ore
The quantity of stream tin raised from the bed of Vegetable Ck by the 11 mines situated along its course (a distance of about 3½ miles) from 1872 to 18?6 was 6252 tons 12 cwt
And from the deep leads (The Vegetable Ck T.M.Co", "Rose Valley" and "Campbell and Gibsons") during the same period was 2425 tons, 1 cwt being a total Yield from the 15 mines of 8677 tons, 13 cwt
The total Value of Plant and Stock on these holdings (including horses, tin stores, Mining plant &c is £7600
The average rate of carriage of ore via Grafton is £7 10/ per ton
do do do do Via Warwick & Brisbane is £6 10/ "

Gordon's
200 acs MLs
This mine has principally been worked in tribute, the small sluice box and sluice fork having been used. The width of payable wash dirt did not average more than 50 ft and from grass to bottom was washed
This mine is considered worked out, the Empire having forfeited most of the land
Yield 163 tons 15 cwt

Six mile Hall Bros & Co 80 acs MLs
17 Men, 2 Horses, 1 sluice box, 1 Puddling machine, 1 Dam
Value of Plant £150
Yield 266 tons

Rothschild
Anderson Hansen & Co 240 acs MLs
20 Men, 2 sluice boxes with hopper plates
Head race from dam when water is plentiful, and Californian Pumps by manual labour 2 Dams Value of Plant £150
Yield 460 tons

From the bend of the Creek at Mess^rs Hall Bros down the water course the wash dirt is nearly ½ boulders The payable deposit commences from this mine to get narrower
Average width of lead 150 ft and 4 ft of stripping

Hall Bros & Co
80 acs MLs
12 Men 2 horses
1 ground sluice
1 Sluice box (hopper plate)
1 Horse pump
Value of Plant £400
2 Dams
Yield 508 tons

Nonpareil
10 acs MLs
17 Men
2 horses 2
Puddling Machines 1
Dam 1 Sluice box (hopper plate) Cal.^n manual Value of Plant £150
Yield 659 tons 2 cwt
Marshall & Co

Little Minnie
10 acs MLs
worked out

Rose Valley
Irby & Co 10 acs MLs
Narrow run of wash traced from the surface to 60 feet in a straight run, sluice box and hopper plate (Dam & Puddling Machine) Value of Plant £200
Yield 222 tons 5 cwt

Campbell and Gibson
10 acs MLs 27 men 3 horses
narrow, rich gutter ground at 80 feet impressions of leaves
Yield 217 tons

Conformation of the rich gutter 90 ft from the surface at 80 ft deep Average width of wash 6 ft Impressions of leaves always found in profusion over the richest patches of tin Yield from August 1876 21 tons
26 men, 3 horses

Morley prospecting Shaft 33 ft
Impressions of leaves near prospect

Baal Gammon
10 acs MLs
Marks & Co
27 men 1
Horses 2
Puddling Machines 1 Dam 1 Sluice box (hopper plate)
Horse pump & Cal.^n
Yield 65 ft 2 cwt

Mess^rs Moore Speare & Co
160 acs MLs
65 men 11 horses 3 Puddling Machines 1 sluice box hopper plate
7 Sluice boxes & other cylindrical Sieves & horse pumping gears
3 Dams Value of Plant £1000
Yield including that from the Little Minnie Mine 1494 tons

Very rich surfacing which was gradually traced into deep ground 60 feet deep, width of lead 1500 feet, average width of wash 200 feet

Little Wonder
10 acs MLs
Irby Andrews and O'Donnell
To men 3 horses 2 puddling machines 3 sluice boxes hopper plates 3 Dams Horse pumping gear Value of Plant £300
Yield 351 tons 2 cwt

Little Britain
10 acs MLs
lately purchased by the Gt Britain Co
Yield 135 tons

Tomison's
Yield 35 tons

Both sides stripping from 6 inches to 9 feet deep

The Great Britain T.M.Co
520 acs MLs 150 men 33 horses
12 horse power Steam Engine 6 Puddling machines 3 Sluices with cylindrical sieves and horse pumping gears 4 Dams Value of Plant £2800
Yield 1126 tons 9 cwt

and through out the Flats

No Mistake
Campbell & Gibson
Cutts Tribute
80 acs MLs
22 men 7 horses
2 Puddling machines
1 sluice box (hopper plate)
Horse pump 1 Dam Value of Plant £200
Very rich deposit of surface ruby tin, partially worked surfacing to 3 feet deep
Yield 190 tons

Veg Creek T.M.Co
Horse Cost £4
prospected supposed shallow

1760 acs MLs
88 men 12 horses Surface tramway 2 Puddling machines 2 Sluice boxes with cylindrical Sieves and horse pumping gears 1 Dam
Value of Plant £1300 Yield 1771 tons 9 cwt

Deep Lead

Creek tin mining

Table

RANGE

GRANITE

VEGETABLE CREEK

(Signed) G. K. Gower
Mining Registrar
Vegetable Creek Division
Clarence and New England Mining Dist

78094

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

VEC

A Sketch shewing the aggregate yield of ore fr

The original features of the upper and richest portion of Vegetable Creek were a "swampy flat, about 2 miles in extent, with a few waterholes at the lower end."*

During the first two years the creek bed alone was worked, which yielded most abundantly; soon, however, tin ore was traced into and under its banks, to the limits of the wider-spread alluvium of earlier stream action, through which the recent stream had sawn its track and reconcentrated the stanniferous burden of the eroded material into its bed.

It is interesting to recall the original productiveness of this lead between 1872 and 1880; and to note that, notwithstanding the phenomenal output of its upper reaches, they have continued to provide a livelihood for many ever since, and even now furnish profitable dredging returns.

The positions of noted mines of the past are shown on G. H. Gower's plan of 1876, which is reproduced. In utilising his work in a publication dealing with the tin industry of the State, it is fitting to record appreciation of the high standard of excellence exhibited in his reports and statistical returns, as Mining Registrar at Emmaville, from 1872 to 1880—the most strenuous period of tin-mining in the State. It is regrettable that the excellent system initiated was discontinued.

From the returns furnished for 1872 to 1880, of the yields of the eleven mines extending about 3½ miles along Vegetable Creek from its head, the following table of outputs has been prepared:—

Period.	Mine.	Area.	Output.	Remarks.
		Ac's.	tns. cwts.	
1872 to 1880 ...	Great Britain	520	3,424-13	
,, ...	Tomison's	20	155- 0	Purchased by Gt. Britain Company in 1875.
,, ...	Little Britain	40	559-12	
,, ...	Little Wonder	40	621-13	
,, ...	Moore and Speare's	160	2,411-19	
,, ...	Baalgammon	40	824- 5	
,, ...	Nonpareil	40	739- 2	
,, ...	Little Minnie	40	.....	Included with Moore and Speare's.
,, ...	Hall Bros.	80	759- 0	
,, ...	(Blank)	...	.....	
,, ...	Rothschilds...	240	1,170- 7	
,, ...	Six-mile (Hall Bros.)	80	393-10	
,, ...	Gordon's	200	194- 0	
	Total	...	11,253- 1	

* David, *op. cit.*

The Great Britain mine is described as being less rich in concentrated wash-dirt, because of its position at the head of the stream rendering it less liable to flooding, but the tin ore was more evenly distributed over a greater width of lead. "The stripping averages about 5 feet deep, and in many places presents the appearance of a ferruginous sandstone. The wash-dirt is about 18 inches deep on a soft claystone reef, and has the appearance of a heap of soft clay with about 50 per cent. of flagstones mixed together, and thus allowed to set. The richest deposits occur where the stones are in greatest abundance and the most cemented."*

At first a tramway was laid for 6 miles to the Severn River, where a steam plant was installed for sluicing purposes, but after a short period was abandoned, as the wash-dirt could be more economically treated at the mine by conservation of water in dams.

In 1877, the mine was let to tributors, amongst whom about 100 Chinese found employment. In 1878, the tin being traced into deeper ground in the banks of the creek, "blocking out" was adopted instead of stripping. In 1879, the output reached 737 tons of tin ore—the whole being obtained by tributors; 120 out of 170 men employed being Chinamen. In 1880, it was announced that all the shallow alluvial mines in the bed of Vegetable Creek were in the hands of Chinese tributors—about 500 obtaining profitable employment.

Moore and Speare's mine—now being dredged by the Great Britain Sluicing Company—was, perhaps, the richest in the Vegetable Creek lead. In 1874 it yielded a dividend of £10,000 for twelve months' work.† The width of the lead was described as 200 feet, the thickness of wash 3 feet, averaging 80 lb. to the load. In some parts the stripping—ferruginous sand and cement—6 to 7 feet thick, required blasting.

In the Little Wonder mine the stripping averaged 4 to 5 feet, and the wash-dirt about 7 feet; in some places the latter required explosives, owing to cemented nature.

The Baalgammon mine paid £10,000 in dividends up to 1875.‡ The wash was very rich in places, one patch yielding 50 tons from an area of 1½ chains by 1 chain in the creek bed. The stripping averaged 5 feet, and the wash 2½ to 3 feet.

Rich patches also occurred in the adjoining Nonpareil mine.

In Hall Bros'. Vegetable Creek mine, the width of stanniferous wash averaged over 300 feet by a depth of 2½ feet; the proportion of stones was, however, very large.

In the Rothschild mine the payable lead averaged 50 to 100 feet, of an average depth of about 4 feet of sandy creek drift, with a large proportion of stones. A large flat, about 900 feet square, on this property was found to be also tin-bearing to a lesser extent.

In Gordon's mine, the last of note along Vegetable Creek, the lead is very narrow, not more than 50 feet wide. From surface to bottom—2 to 5 feet—was sluiced.

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* Mines and Mineral Statistics, 1875, p. 65. † G. H. Gower, Mines and Mineral Statistics, 1875, p. 64.
‡ Ann. Rept. Dept. Mines, 1875, p. 101.

Below this mine for a considerable distance Vegetable Creek becomes rock bound and full of stones and boulders.

David mentions 15,000 tons of tin ore having been won from Recent and Pleistocene alluvials of the Vegetable Creek, between 1872 and 1884 inclusive, from its source downwards for over 5 miles ; which worked out at about 100 tons per acre.*

Vegetable Creek Deep Lead.—The chief interest of alluvial mining at Emmaville naturally now centres in the unworked extensions of the basalt-covered deep-leads. A stimulus has been given to this class of mining by the Vegetable Creek Deep Lead Tin-mining Company's success in the old Phœnix shaft at the lower end of the worked area, and still more recently by their discovery of rich wash from the Rock Shaft, about 30 chains further down the old channel.

In these notes on the leads within the area covered by David's map and memoir, the aim is to supplement the work already published by a resumé of discoveries and developments since its issue.

A brief epitome of the progress of development, however, is useful in leading up to the subject. The first record of the above lead is given by G. H. Gower in his report for 1874.† Its head was then being worked by the Vegetable Creek Tin-mining Company, in Portion 231, Parish Strathbogie North, about a $\frac{1}{4}$ mile south of the main workings in the bed of Vegetable Creek. Mr. Gower was of opinion (subsequently endorsed by Professor David) that :—" The lead in this mine has apparently no connection with that worked in the creek, as the wash-dirt is a regular river-bed drift and gravel, while the latter in some places is a coarse creek wash, but is mostly a cement and clay wash, that requires puddling before the tin can be extracted. A main tunnel has been driven 2,000 feet along the course of the lead, the width of which is from 18 feet to 400 feet, with an average thickness of 3 feet of excellent paying dirt." The face was then about 60 feet below the surface, and the sinking so far through pipeclay. In some parts of the lead in the 60-feet ground there were 14 feet of loose drift sand heavily intermixed with tin ore. The Vegetable Creek Tin-mining Company in 1875 held 1,200 acres of mineral land under conditional purchase,‡ embracing part, at least, of the first deep stanniferous basalt-covered lead discovered and successfully worked in the State.

In view of the continuous conflict between the interests of mining and settlement wherever metalliferous channels or leads underlie rich volcanic areas, it is not without interest to recall the warning published at this early date against alienation, by an able officer of this Department—G. H. Gower—who was brought into actual contact with its hampering influence on the mining industry :—

> " *Red Hills or Volcanic Formation.*—Another matter of the greatest importance to the advancement and development of this district, to which I would wish to call the attention of the Honorable the Minister for Mines, is that of allowing pastoral tenants and free selectors to monopolise such extensive areas in the vicinity of Vegetable Creek. I refer especially to that soil known as red or volcanic. It has been bought and selected in very large areas lately, not for the purpose of

* Geol. Veg. Creek 1887, pp. 65-6. † Mines and Mineral Statistics, 1875, p. 61. ‡ Ann. Rept. Dept. Mines for 1875, p. 103. (*Op. cit.*)

working for minerals, but for grazing and agricultural purposes, the soil being very rich, and the grass growing on it very fattening. Some of the richest deposits of tin, the deep leads, are now being found associated with such formation. But if squatters and selectors are allowed to buy up all that class of country in this neighbourhood for grazing or agricultural purposes, it will at once give a severe blow to the advancement of this important branch of mining."

Much of the lava sheet covering the early stanniferous drainage channels of the district was alienated before reservation protected mining interests.

Mineral conditional purchases, instead of furthering the mining industry, have, in some instances at least, certainly had an opposite effect. Not being amenable to the provisions of the first Mining on Private Lands Act nor of the present Consolidated Mining Act, except as regards gold-mining, owners could let them remain idle or exact unreasonable terms from those willing to work them.

Considering the necessarily slow and costly prospecting entailed in attempting to trace the courses of buried channels beneath wide sheets of solid basalt, frequently enhanced by running drifts and heavy water, any charges beyond those fixed by the Mining Act must have a deterrent effect. Certain it is, the continuation of the Vegetable Creek deep lead remained unproved and unattempted for many years.

Exhaustion of other sources of tin supply, and the high market value ruling for the metal of late, has stimulated the present efforts of the new Vegetable Creek Deep Lead Company.

In his report for 1875, G. H. Gower states that 741 tons of tin ore were obtained by the original Company from 2 acres 11¼ perches of the lead worked during that year. The width of the face had increased to 600 feet. The average thickness of paying wash was 3½ feet throughout the full width of the face.

The wash-dirt in several parts of the lead had sometimes a depth of 7 and 8 feet of sand, with very fine tin all through it, and below this, lying on the soft decomposed granite bottom, were 18 inches to 2 feet of gravel, in many parts half of it tin ore. This gravel was composed of round pebbles and water-worn pieces of quartz, with very fine tin all through them.*

The output from the lead reached a total of 1,795 tons 9 cwt. at the end of 1876. The Company expended a large sum prospecting ahead of their workings, but were not very successful. About half-a-mile ahead a narrow but fair run of wash was struck at a depth of 80 to 90 feet; the width averaged 10 feet, and the yield 20 tons from a length of about 900 feet.

The output was increased to 1,976 tons 13 cwt. at the end of 1877. Efforts to trace the run of the lead south-westerly this year were continued; but nothing as rich as the first main deposit was struck. Channels were found at depths varying from 65 to 80 feet.

W. H. Wesley was also endeavouring to trace the deep ground through his adjoining portion of 180 acres on the north-west. Nine shafts were sunk, varying from 50 to 95 feet in depth. Several passed through the volcanic formation—one through 70 feet of hard rock; in others only a few feet occurred.

The tin ore was mostly on the bottom, the best wash being about 4 inches thick. The width proved about 40 feet.

* Ann. Rept. Dept. Mines for 1875, p. 104.

The following section of the most northerly shaft is given by Mr. Gower :—*

Surface.
13 ft. red clay.
6 ft. pipeclay.
13 feet fine drift and clay.
16 feet pipeclay.
1½ feet payable wash-dirt.
Decomposed granite bottom.

In the following year the gutter in this property had been proved for 300 feet in length, 40 feet wide, with 3 feet of payable wash, from which 106 loads had yielded 4 tons 11 cwt. of tin ore.

Messrs. Griffiths and Hammond, in 1879, discovered rich wash at 65 feet in Irby & Company's property on the west, averaging about 2 cwt. to the load. The width of lead varied from 25 feet to 200 feet, and the thickness averaged about 1 foot.

In endeavouring to pick up the above lead, Messrs. Wesley, after sinking and driving about 1,000 feet, without success ; in another shaft near their boundary struck rich wash at 130 feet, after sinking 90 feet through basalt. This property was sold in 1880, and floated into a company, with a capital of £40,000, Messrs. Wesley's operations having proved the lead for a length of 340 feet, and a width of 170 feet.

Messrs. Flannery and party, in a portion of the Company's property, a quarter of a mile distant, bottomed at 210 feet with 3 feet of good wash, but were at first driven out by water. The lead was subsequently opened for length of 200 feet, and a width of 70 feet.

The nature of the upper portion of the lead and its tributaries, as proved up to 1884, can best be ascertained from the following description by David,† which has a practical bearing on its probable character in the still unproved reaches :—

"The Lower Vegetable Creek Deep Lead was first worked at its source as a shallow deposit, at 18 feet from the surface, in portion 231, Strathbogie North, at a distance of over a quarter of mile south of the main shallow workings on Vegetable Creek. The overburden consisted chiefly of pipeclay, and the sand or gravel composing the wash-dirt had an average thickness of 3 feet. The tin ore was black and well worn, that on portion 232 containing pellets up to ½ inch in diameter. The stanniferous gravel was found to run in a well-defined belt, at first westerly, and then south-westerly ; and was followed by means of a tunnel, 2,000 feet long, shafts being sunk at intervals. The surface of the ground was nearly level, but that of the underlying tin gravel was found to have a gradual slope to the south-west ; here the gravel would widen from 18 feet to 90 feet, there it would become contracted again, and in places thin out altogether, and for a chain or so there would be no tin, merely a channel in the rotten surface of a white quartz-porphyry, choked with pipeclay. Such blank spaces in the lead were generally found to occur where the fall was more than usually steep, for when the bottom became more level the tin-bearing gravel invariably became thicker and richer. At one point in the main workings, near the roadway between portions 232 and 233, a good run of wash, 3 to 4 feet thick, was cut under a layer of hard cement, 14 inches thick, and 16 feet below this again the main

* Ann. Rept. Dept. Mines for 1877, p. 148. † Geol. Veg. Ck., 1887, pp. 85–90.

lead was worked. There could be little doubt, from the shape of the lead and the general character of the tin-gravel, that the Vegetable Creek Tin-mining Company had struck an old river channel, and subsequent explorations have fully confirmed that supposition. At a distance of about 12 chains from the source, a hard blue rock was met with in sinking, overlying the pipeclay and tin gravel, and as the tin continued to dip deeper under the tertiary country, this hard rock roof progressively thickened. At a quarter of mile from the point of commencement, at a depth of 47 feet from the surface, the beginning of an extremely rich patch of tin gravel was struck—the underground channel widened from 30 to 400 feet, and the depth of tin-bearing sand and gravel in places reached as much as 14 feet, with an average thickness of 3 feet. A small feeder was found to come in from the east here, in portion 233, which has since been partially worked.

"The main patch gradually became narrower as the slope of the channel was followed down to the south-west, and at the north-east corner of portion 235, at a depth of 60 feet from the surface, the tin gravel thinned out completely. The richness of this patch may be inferred from the fact that it yielded 2,000 tons of tin ore out of an area of 5½ acres of gravel, averaging 3 feet thick, *i.e.*, it yielded over 1½ cwt. per cubic yard.

"From here the lead was proved at intervals running south-west through Cubis' ground, portions 237 and 718. In Cubis' ground an upper bed of tin gravel was cut at 45 feet from the surface, separated from the underlying main deep lead by 28 feet of basalt. This upper lead was found to have a fall in a direction exactly opposite to that of the main lead. The seam of gravel probably forming the source of this run was struck in Watson's 82-feet shaft, in portion 718, Strathbogie North, at 12 feet from the surface.

"In portion 718 the lead took a very sharp bend, being doubled almost back on itself, and on the inside of this elbow a rich feeder, known as the Old Rose Valley lead, was proved to join it from the north. This was discovered by Mr. Reynolds at the surface in portion 230, and traced thence for a distance of 16 chains. The actual point of junction has not yet been proved, but it is probably situated close to the sharp bend shown on the plan. The lead worked by Webb, in portion 718, for 6 chains south-west of this corner, although it belongs to the main lead, was probably a reef wash swept into its present position by storm-water, which would be apt to scour the gravel over the edge of the outer bank at this sharp turn and deposit it on the flat ledge where it now rests, 10 feet above the bottom of the main channel. The extension of tin gravel in this direction has been regarded by some as proof of the existence here of a channel connecting the Vegetable Creek and Grave-yard leads. The pipeclay underlying the basalt at this point contains a profusion of fossil leaves and ferns.

"From here the lead runs north-east to the east boundary of the Wesley ground, the fall in the channel increasing from 1 foot in 104 feet to 1 foot in 58 feet, and this increase in the fall is attended with a narrowing of the channel and thinning out of the tin gravel. The channel, however, though only 2 feet wide in places, has been proved to be payable throughout the greater part of its distance, as far as the east line of portion 41. Hamilton, at which point a bed of palæozoic con-

glomerate has interfered with the regularity of the channel, apparently splitting it into several narrow gutters, the southernmost of these, known as Hamilton's lead, has been lost just after it enters the Wesley ground. Hume's lead is probably a continuation of it. A very rich patch of tin gravel has been worked north of Hamilton's lead and west of the conglomerate bar, at the north-east corner of portion 41, Hamilton. The stream beds here are from 130 to 137 feet below the surface, the richest part of the ore-bearing bed being within 4 feet of the bottom rock, and averaging 70 lb. per cubic yard. The patch was 260 feet wide and 370 feet long.

"Near the west end of the patch is the probable junction of the second rich feeder from the north, viz., Fox's deep lead. This lead has been traced to the roadway between portions 719 and 723, Strathbogie, where it was struck at 88 feet below the surface, the overlying strata being chiefly red clays, volcanic dust, and soft pink basalt. From there the feeder was traced west for $\frac{1}{4}$ mile into the Wesley ground, where it joins the main Vegetable Creek lead at a depth of over 140 feet below the surface. Overlying Fox's tributary deep lead is an upper lead named after its discoverers, Griffiths and Hammond. A sheet of soft pinkish-grey basalt, 30 feet thick, separates the upper from the lower lead. Some of the alluvial tin in Fox's tributary is very coarse, and fragments of tin-bearing veinstone, several inches in diameter, are of frequent occurrence in the tin gravel. West of the confluence of Fox's tributary with the main Vegetable Creek deep lead, the main lead has been proved 10 chains further to the south-west, as far as the New Whim shaft (153 feet deep). At this point there appear to be two distinct kinds of tin-bearing gravel, one, a loose white wash composed of clean quartz sand and water-worn pebbles, and lumps of eurite, about 10 feet above the deepest channel, from 1 to 2 feet in thickness, and yielding 50 lb. of tin per yard; the other, a coarse iron-cemented gravel, 8 feet thick, yielding 70 lb. of the ore per yard.

"The quartz-porphyry (or eurite) at this shaft contains thin veins of quartz and tinstone, and in the drives, wherever its junction with the claystone can be observed, its intrusive character is very apparent. At this shaft, on Hume's old lead, the tin gravel is shut off abruptly against basalt, which rests immediately on the bottom rock. From here to Griffith's shaft, 15 chains west-south-west, the lead has been lost. At Griffith's Shaft an upper seam of tin-sand, much stained with oxide of iron, was struck at 60 feet from the surface. This was probably a continuation of a shallow lead worked in the Wesley ground 5 chains north of Hamilton's deep lead. Under the tin-sand 91½ feet of basalt were pierced, then 6 feet of drift sand overlying stanniferous sand and gravel cemented by limonite, like Hume's deep lead. From here the lead enters the area known as Flannery's Tribute. At this point the quantity of water in the alluvials proved a great obstacle to the further development of the lead. The serpentine course of the lead through this area, and the well-defined rocky sides rising almost vertically to 12 feet above the bottom to form the banks enclosing gravel, combined with the fluviatile character of the beds, prove that the lead here is an old water-course; the fact being still further confirmed by the presence, higher up the lead in the Wesley ground, of abundant remains of land plants preserved in the pipeclay. . . . . The channel was worked here for a distance of 30 chains; the width varied from 20 to 140 feet, averaging

80 feet, and the thickness of the wash ranged from 1 foot to 13 feet, the average thickness being about 6 feet. The total amount of ore won from this portion of the lead—1,600 tons, *i.e.*, over 100 lb. of ore per cubic yard of wash-dirt. From the sharp bend to the south line of portion 120, Hamilton, Flannery's lead was worked down to the water level, on a false bottom of fine sand, cemented in places with a clayey material. Monkey shafts put down in places not having yielded encouraging prospects, it was decided not to go to the expense of draining the underlying sands.

"Subsequent, however, to the expiration of Flannery and party's contract with the Wesley Company in July, 1883, O Rourke and party, assisted by Fox's bailing lower down the lead, were able to prospect the underlying gravels, and after passing through 12 feet of fine sand and sandy clay, came upon very rich wash, from 1 foot to 4½ feet thick, resting on the true bedrock. The wash was composed of sand, passing into gravel and coarse shingle. The sand was made up of rounded and angular grains of quartz, mostly having the shape of a double hexagonal pyramid, and gravel of smooth pebbles of quartz-porphyry and quartz. There is evidence, therefore, here, as at Hume's lead, of two rich grades of tin gravel—the lower resting on the bedrock, averaging 2 feet in thickness; the upper averaging 5 feet, and separated from the lower level by 12 feet of sand and clay. North of O'Rourke's, the lead passes into Fox and Company's 17½ acres block, and immediately over the lead here, on the surface, are two large patches of ironstone and iron-cemented sandstones.

"The strong body of water in the deep alluvials here, as well as in the next claim (Bailey's), have made the task of finding the channel very difficult and expensive. At the south-west end of the property an upper run of wash was worked, from 5 to 6 feet in thickness, but scarcely payable; 18 feet of fine sand parted this upper run from the gravel of the main channel, the latter being 6 feet thick. The depth below the surface of the lower level wash here is about 160 feet. Through Fox's ground the main lead trends north-north-east into portion 20 (Hamilton), where Bailey's party are now working the lead. After three years of constant work they have found the main deep lead channel and worked it for a distance of over 8 chains. An upper level of fine stanniferous sand was proved here under the basalt, considerably above the tin-gravel of the main channel. The drives in Bailey's workings afford excellent sections showing the line of junction between the eurite and claystone, or Lydian stone, as it may be more accurately termed. . . . . This hard bar of Lydian stone . . . . is evidently the cause of the lead having been diverted from its westerly course in the middle of Flannery's workings and shot northerly through Fox's and Bailey's. Immediately over Bailey's deep channel an upper gutter was worked above the basalt, known as Proctor's shallow lead, so that here there were two grades of wash under the basalt and one above. The shallow lead was worked at a depth of from 16 to 80 feet from the surface. This is the lowest point to which the continuous workings on the main lead, from its source downwards, have been carried. The above observations justify the inference that these deep leads of stanniferous gravels occupy the channels of an old river and its tributories; which for the rest of its course must obey the known laws affecting rivers.

The lead must have a constant fall in its bed in the direction of the lowest point at which there was an outlet for its waters, and it will be enclosed between banks more or less defined.

"The channel, wherever the current has not been strong enough to sweep it bare, will be covered with gravel, and wherever the country drained by the lead is stanniferous, these gravels will contain stream tin. The bottom of the channel—from Vegetable Creek (Emmaville.—J.E.C.) down to Flannery's shaft, a distance of 125 chains, measured in a straight line in the direction of the general trend of the creek—is 114 feet (= about 1 in 58½). The length of the channel is 165 chains, of which 115 chains contained tin gravel, while 45 chains were blank. The total amount of ore recorded as having been raised from the main deep lead from 1872 to 1884, between the old Vegetable Creek dam and Bailey's, is 4,478 tons."

"*Unproved ground on the Vegetable Creek Main Lead.*—Following the basaltic country westwards from Bailey's, a number of shafts have been sent by Cunneen in the eastern half of the portion. A channel has lately been discovered, at the point shown in the north-east corner of portion 5, which is considered a continuation of the main deep lead. Seventeen chains further to the west-south-west in the same portion, Moran has struck a channel 103 feet to water level, with a slight bar rising to the north and south.

"The Rock Shaft in portion 2 was bottomed by means of boring rods at a depth of 209 feet, the greatest thickness of sedimentary material yet met with being passed through in the shaft.* In Skinner's shaft in No. 1 (portion 1.—J.E.C.), and in Hart, Flannery, & Co.'s shaft, an upper seam of sand was reached at depths respectively of 100 feet and 91 feet from the surface. At Barry's, still further west, in portion 52, Strathbogie, rich tin gravel has been worked for a short distance. The tin gravel was rendered more accessible here by the removal, through the erosive power of Stony Creek (Two-mile Creek.—J.E.C.), of the overlying basalt. The sinking from the surface to the bed-rock was through tough, fine sand and clay; the depths of the shafts ranging from 58 feet to 66 feet. The bottom, which was of claystone, was found to be very uneven, so that it was hard to determine the direction of the channel; the bearing seemed to be west 20° south. The width was 100 feet, and the average thickness of wash 3½ feet. The wash consisted of clean, well-worn, quartz-porphyry sand and pebbles, and blocks of rounded claystone, the latter being as much as 2 feet in diameter. The roof is pipeclay. The average yield of this gravel was 1 cwt. of tin ore per load. Five chains west-south-west of Barry's, Kelly and party (late Bourke and party) found a rich patch of gravel, like that in Barry's, which has since been proved to pass under the bed of the present Stony Creek (Two-mile Creek.—J.E.C.). Several prospecting shafts have been sunk between Barry's and Kangaroo Flat, the most important being Messrs. Wesley & Co.'s prospecting shaft in portion 137, Arvid. Several distinct sheets of basalt were passed through from the surface downwards. At 247½ feet from the surface sand was struck, passing towards the base of the bed, which was 7½ feet thick, into a rubbly gravel, composed chiefly of claystone. This rested on a false bottom of basalt; the shaft was sunk a further depth of 25 feet into this basalt without striking gravel,

* This shaft has since been sunk to 210 feet (see plan). The patch of wash struck in a drive from it measured 1,431 cubic yards, which yielded 76 tons 0 cwt. 2 qrs. 15 lb. of tin ore, an average of 119 lb. per cubic yard.—J.E.C.

being still in the lava when work was discontinued. The total depth of the shaft was 280 feet. The bottom of the gravel is 125 feet above the wash at Kangaroo Flat, 480 feet below Fox's shallow lead at the south shaft, and 310 feet below the level of the bottom lead at Barry's. Alluvial tin has been worked on a small scale at two points intermediate between Bourke's and Kangaroo Flat. One at Mt. Doubtful, in portion 143, Arvid. This is an outlier of red sand about 5 acres in extent, capped by lava. The sands are current bedded, and partly cemented by red peroxide of iron; gray patches of clay lend the deposit a mottled appearance, like the stanniferous sands at the Y Water Holes. The beds are about 10 feet thick, and are rather poor in stream tin. The sand is 280 feet above that in Wesley Extended Shaft.

"Hogan's lead was worked in portions 86 and 87, Parish of Arvid, for about a length of $\frac{1}{4}$ mile. The tin wash was partly capped by volcanic dust and rotten pink basalt. The sinking here was comparatively shallow—from 10 to 20 feet."*

RECENT PROVINGS.†

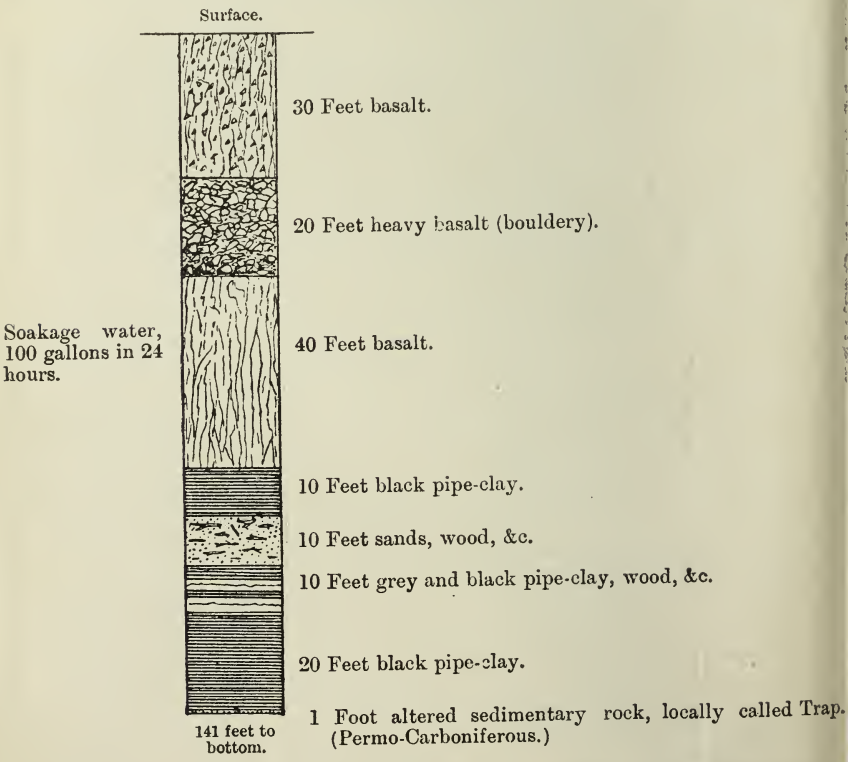

Surface.
30 Feet basalt.
20 Feet heavy basalt (bouldery).
Soakage water, 100 gallons in 24 hours.
40 Feet basalt.
10 Feet black pipe-clay.
10 Feet sands, wood, &c.
10 Feet grey and black pipe-clay, wood, &c.
20 Feet black pipe-clay.
1 Foot altered sedimentary rock, locally called Trap. (Permo-Carboniferous.)
141 feet to bottom.

Fig. 4.—Section of Deep Lead, Rose Valley Tin Syndicate, Portion 49, Parish Hamilton, County Gough. Close to Barry's old workings.

* Geol. Veg. Ck., 1887, pp. 97–8. † A shaft was being sunk in February, 1911, in Portion 50 by the Vegetable Creek Tin Mining Company, with a view of proving the lead below the Rock Shaft.

S.E. Cros

ROC

Basal

Drift sand

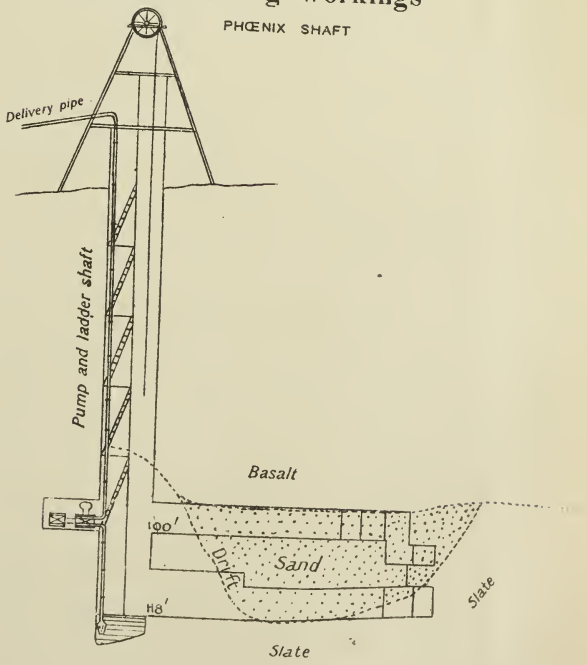
Lignitic clay

00′

00

00′

Section showing workings



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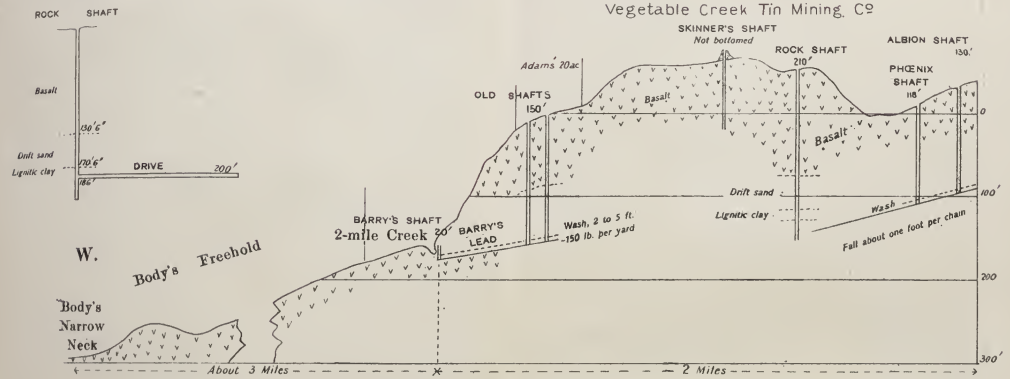
Section from Body's Narrow Neck to the Albion Shaft near Strathbogie, Emmaville.

Horizontal Scale 0 20 40 Chains
Vertical Scale 0 80 160 Feet

After P.V. Tuxen

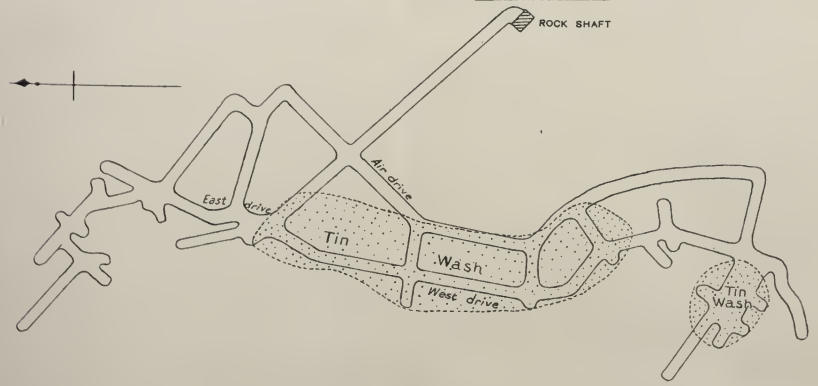
Cross Section N.W. E.

Vegetable Creek Tin Mining Co



Plan of workings *After J. Burgin.*

Scale 0 40 80 Feet



Section showing workings

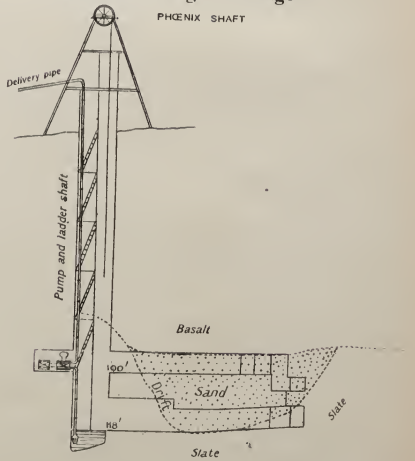


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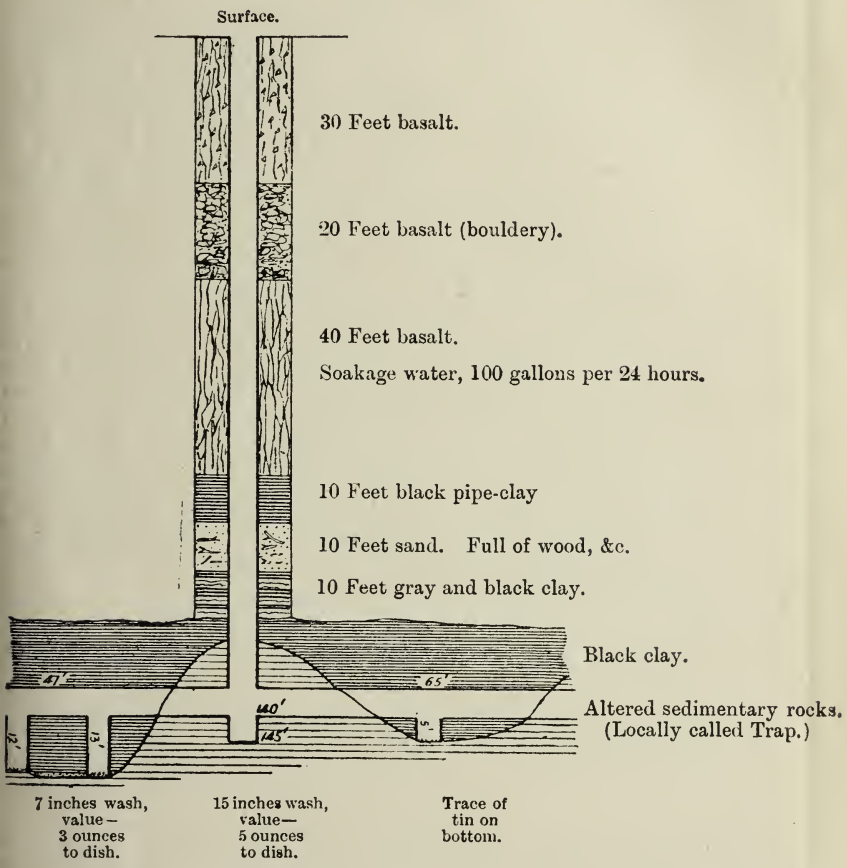
PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

Fig. 5.—Section of Adams' Shaft, 2-Mile, Rose Valley Deep Lead, Portion 52, Parish Hamilton.


Surface.
30 Feet basalt.
20 Feet basalt (bouldery).
40 Feet basalt.
Soakage water, 100 gallons per 24 hours.
10 Feet black pipe-clay
10 Feet sand. Full of wood, &c.
10 Feet gray and black clay.
Black clay.
Altered sedimentary rocks. (Locally called Trap.)
47'
65'
40'
125'
7 inches wash, value— 3 ounces to dish.
15 inches wash, value— 5 ounces to dish.
Trace of tin on bottom.

Kangaroo Flat.

Tin was first found under the basalt of Kangaroo Flat in 1875. Several tunnels up to 200 feet were driven in that year from the sides of the Vegetable Creek valley, but nothing remarkably rich was discovered. In 1878 Messrs. Hall Brothers erected a 9-head stamp battery to deal with the large amount of cemented drift encountered in the wash. From the basalt plateau the lead was reached at 115 feet, 90 feet through hard basalt. The gutter was here about 30 feet wide.

David has described this lead and its surroundings from geological survey during operations. Satisfactory inspection is now only possible in rare cases.

"*Kangaroo Flat Lead.*—The plan of the basaltic country and comparison of the levels show that this lead is a continuation of the united Vegetable Creek and Graveyard leads. The existence of tin gravel here was proved by the discovery of stanniferous gravel outcropping from under the basalt where the lava flow had been cut away by the present Vegetable and Glen creeks, near the north-east corner of portion 45, Arvid, at the Avoca mine, near the north-east corners of 104 and 105

in the same parish. The tin gravel here, which is capped by basalt averaging 90 feet in thickness, has been worked in two channels on a nearly level bottom of claystone. The east channel has been worked for 30 chains, and the west for 35. The width of payable gravel varied from ½ chain to 4 chains, averaging 1½ chains. The gravel averages 2 feet in thickness, and is composed principally of flattish oval pebbles of claystone 2 to 3 inches in diameter, and well-worn pebbles and grains of quartz; and gem-stones, as green beryl, emerald, sapphire, topaz, &c., and fine grains of stream tin chiefly black. A great deal of clayey material is mixed with the sand and gravel, and this having been converted almost into brick by the heat and pressure of the overlying basalt has turned the gravel into a species of conglomerate, so that one-half has to be puddled, and crushed under stampers before the tin can be extracted. The stream tin is distributed more plentifully through the thin fine gravels at the sides of the channels than in the coarser gravel lying in the channels themselves; so that the stanniferous gravel here may be described as a reef or beach wash. The total amount of ore raised here from 1872 to 1882 has been 909½ tons. As the bottom is so nearly level throughout it is hard to say whether the channels from which this ore has been obtained are one and the same, or two separate approximately-parallel leads. The level of the reef wash at Kangaroo Flat, as ascertained by aneroid, is 710 feet below the Post Office at Emmaville, and 690 feet below the source of the Vegetable Creek deep lead. The distance from the last point to the south end of the Kangaroo Flat workings, measured along the general course of the lead, is 13½ miles, giving an average fall of 51 feet per mile.

"At the Avoca mine, ½ mile north of Kangaroo Flat, an outcrop of coarse, well-worn shingle, from under basalt, has been worked on a small scale for stream tin, but found not payable. The gravel is far coarser than that at Kangaroo Flat, some of the blocks being 2 feet in diameter. The full thickness of the gravel here has not yet been proved, but cannot be less than 10 feet; the level is about 60 feet below the Kangaroo Flat gravel.

"Stormer and party have found a patch of payable tin-sand in portion 111, Arvid, at a depth of 130 feet from the surface; the sinking was for 65 feet through fairly hard basalt, and then laterite and red clay. The bottom of the channel, as far as was proved at the time of my visit, was 15 feet below that of the wash at Kangaroo Flat. Another outcrop of tin gravel has been worked by Foley and party 1½ miles west of Kangaroo Flat; two grades of gravel have been discovered here, the upper covered by volcanic dust worked at 80 feet below the surface, on a bottom of basalt, at a level of 115 feet above Kangaroo Flat; the upper tin-sand averaged 2 oz. to the dish, *i.e.*, 30 lb. per cubic yard; the shaft was sunk to a total depth of 120 feet, the remainder of the sinking being in hard basalt; the bottom of the shaft was 75 feet above the level of the wash at Kangaroo Flat. In the adjoining portion 151, Arvid, the lower grade of wash, consisting of gravel, was proved at a depth of 80 feet from the surface, the capping being hard basalt. This wash is composed of pebbles 2 to 3 inches in diameter, of claystone and quartz-porphyry with quartz sand. Some of the pebbles are 1½ feet in diameter, and the gravel is coarser than that at Kangaroo Flat; the tin, however, which is chiefly black, is finer than that at Kangaroo Flat; the gravel is 7 feet thick in places, and averages from 25 to 30 lb. per cubic yard.

" Half a mile south-west of Foley's is Hall's Sugarloaf, a small outlier of basalt capping stanniferous gravel. The basalt, which is hard, is 170 feet thick, and the tin gravel crops out on the south-west, south-east, and north-east ends of the outlier, the channel (if there is one) appearing to run from south-east to north-west. The gravel here, as described under General Geology, has been much indurated by the heat and pressure of the superincumbent lava, which has ridged it up into waves, so that the thickness is very variable, being from a few inches to 2 feet. The deposit may be described as a 'cement' consisting of pebbles of claystone 3 inches in diameter with small well-worn quartz pebbles, quartz sand, and small gems, as topaz and beryl, set in white and grey pipeclay, which has been baked in places into a tough natural brick. The cement is cleaner than the gravel at Kangaroo Flat and at Foley's, and is richer in stream tin. The stream tin, which is chiefly black, averages $\frac{1}{30}$ inch in diameter; the larger black grains associated with it are chrome spinel. The level of the cement at the north-east end of the outlier is 120 feet above that at Kangaroo Flat. One mile north-west of Hall's Sugarloaf are the 'Surprise Mines.' The gravel here is far coarser than that at Hall's Sugarloaf, Foley's, or Kangaroo Flat, and resembles that at the Avoca mine, some of the water-worn blocks being 2 to 3 feet in diameter. The gravel lies in three distinct terraces, the top and middle terrace being richer in tin than the bottom. The floor on which the shingle rests in the top terrace is 62 feet below the wash at Hall's Sugarloaf, and 58 feet above that at Kangaroo Flat. That in the middle terrace is 42 feet above Kangaroo Flat, and in the bottom terrace 190 feet below. The top and middle terraces have been practically worked out, and have yielded over 150 tons of stream tin, the area worked being about $1\frac{3}{4}$ acres, the wash being from 3 to 16 feet thick and yielding 9 to 10 lb. of ore per yard. On the second terrace the gravel is from 10 to 30 feet thick, and yields 30 lb. to the load when the large blocks have been picked out. Some of the wash yielded 5 cwt. to the load. The trend of the beds is about north-west and south-east. Colours of gold have been found here. On the bottom terrace a considerable area of gravel remains unworked. This has been prospected by Messrs. Hopper and Bottrell (for Moore and Company), who have followed the gravel into the basalt from its line of outcrop for a distance of 450 feet. The bottom of decomposed quartz-porphyry was fairly level throughout, but rose rapidly at the far end of the drive. The bearing of the channel here is evidently north-west and south-east, and can be traced at intervals for three-quarters of a mile from Hopper and Bottrell's camp to the middle of portion 133, Parish of Athol, County Arrawatta. The capping of basalt at the deepest point is from 160 to 170 feet thick; the thickness of the gravel averages 6 feet; and the width is as much as 5 chains in places. The coarse blocks of stone in the gravel, from 1 to 2 feet in diameter, render it impossible to treat the whole of the wash-dirt simultaneously in the sluice-box; the larger lumps having to be carefully picked out by hand first. When this has been done the remaining sand and gravel yields as much as $\frac{1}{2}$ cwt. of ore to the load; the average yield is 15 lb. per yard. The useless coarse blocks, however, detract from the value of the deposit in two ways. First, they take up a large proportion of the weight of every cubic yard of gravel raised; so that to get 1 yard of wash it is necessary to raise 3 yards of gravel; then in the second place the necessity of their removal from the wash increases the cost of treatment. As there is an excellent

outlet for the tailings along the whole line of outcrop of this gravel, and a good supply of water could easily be obtained by enlarging the dam on the creek flowing through portion 290, a modified method of hydraulic sluicing might be adopted for the economical saving of the tin ore. The capping of basalt might prevent the gravel being sluiced away in position, but the separation of the ore could be effected in this way if the gravel to be treated were simply brought to the mouths of the tunnels. The quantity of ore is probably between 400 and 600 tons, *i.e.*, assuming the area to be 33 acres, and the average thickness of the gravel 3 feet, only 1 out of every 3 yards can be considered wash yielding $\frac{1}{4}$ cwt. of ore, an amount which would not justify the outlay of much capital.

"A coarse shingle similar to the preceding occurs at the Fishing Grounds, portions 205 and 206, Arvid. The gravel here is 4 to 10 feet thick, and 200 feet below the level of the wash at Kangaroo Flat. Between Kangaroo Flat and Bailey's mine expensive prospecting operations have been carried on for over three years. The part of the lead which has claimed most attention is that between Bailey's and the Two-mile, and the basaltic spur north of Bailey's known as the Red Hill."*

Since David wrote the above descriptions, several attempts have been made by companies to further develop the basalt-covered drainage leads at the lower end of the Vegetable Creek tin-field, the principal being in 1887 and in 1909–10.

In the former year the Basalt Prospecting Company carried on vigorous prospecting, and at times obtained fair prospects, but nothing payable. Operations were continued until the main tunnel (Fish Ponds) had reached a length of 1,000 feet in 1889. In 1890 the work was abandoned, because of failure to discover payable wash.

The drift and abundant boulders testified to the volume of water flowing in this old river, at all events, in flood times.

In 1910 the Vegetable Creek Deep-lead Company opened the Avoca and Blue tunnels below Kangaroo Flat, for about 750 and 300 feet respectively, to May, 1910. In the former the wash is from 4 to 13 feet in thickness, and very coarse in texture. The richest gutters sampled about 15 lb. of tin ore to the cubic yard, but were of small extent. The general average was reported as about $4\frac{1}{2}$ lb. The lead was also cross-cut for 135 feet.

The Blue tunnel starts from the west bank of Kangaroo Flat Creek, and so far as picked up was below wash level; two rises were put up 18 feet to wash, which here has a thickness of about 5 feet. One rise sampled at the rate of $4\frac{1}{2}$ lb. to the cubic yard.

The same company picked up the Fish Ponds tunnel (1,000 feet long), and found an average thickness of 6 feet of wash, which sampled only at the rate of $1\frac{1}{2}$ lb. to the cubic yard.

"*The Red Hill.*—Levels taken at the lowest points of outcrop along this hill show that the stanniferous sands underlying the basalt cannot belong to Fox's shallow lead, and must, therefore, be a tributary of the main Vegetable Creek lead, standing in the same relation to it as Partridge's shallow lead to Fox's shallow lead. Although the deepest channel here has not yet been found, there is sufficient evidence for inferring that the fall is from north to south. There is a fall of 37 feet from the bottom of the wash at the north end of the hill to the mouth of Hart and Swyny's tunnel in portion 339, Hamilton; and a fall, from the outcrop

* Geol. Veg. Ck., 1887, pp. 93–96.

in the north-west of portion 9, Hamilton, to the bottom of the 50-feet shaft in the same portion, of 26 feet. The deepest ground as yet proved is that at the 50-feet shaft, and it is probable that the channel lies between this shaft and the south-east corner of portion 9.

Summary.

"The facts above stated with regard to the worked portions of the lead, and the prospecting done on the unworked portions, justify inferences with respect to the unworked area; first, as to the position of the channels; second, as to the probability of gravels in the unproved ground containing a fair percentage of stream tin.

"1. Two questions are to be decided with regard to the position of a channel,—(*a*) its depth below the surface, supposing it to underlie any given point of which the level is known,—(*b*) its course underground, determined with reference to fixed points at the surface. As regards (*a*), a lead must, in obedience to the laws which govern rivers, have a constant fall from its source to the lowest point of outlet. There can be no doubt as to the source of these leads, but some doubt attaches to the position of the true outlet. And the question of depth is still further complicated by the fact that, while at the sources of the leads the older gutters lie at lower levels than the corresponding newer ones, at the ends of the leads the older are at higher levels than the newer, as proved at the Surprise mine. As regards the position of the points of outlet for these two gutters, four localities may be suggested, viz.:—

1. The Fishing Grounds.
2. Kangaroo Flat.
3. The Avoca Mine.
4. Foley's.

The deepest channel cannot have discharged itself by way of Foley's, the outcrop of gravel there being 55 feet above Kangaroo Flat. If the deep lead debouches at the Avoca mine, it must pass under the narrow belt of basalt in portion 110, Arvid, which is scarcely probable. It is still less probable that the paltry outcrops at Kangaroo Flat, 13½ miles below the point where the lead was first struck, mark the point of discharge for a river channel which contained water-worn blocks 1 foot in diameter, at 2 miles below its point of commencement. The outcrop at Foley's may be the point of outlet for the upper channel, or may belong to a feeder flowing north-east into the trunk lead. The evidence favours the supposition that the deepest main channel underlies the principal mass of basalt, and terminates at the Fishing Grounds, at the north corners of portions 205 and 206, Arvid. Assuming such to be the case, the fall from the commencement of the lead followed that of the general surface of the country, and assuming that it ran in a straight line, a horizontal section of its bed would be a curve gradually increasing in steepness towards the source. The course of the lead, however, being sepentine or zigzag, it follows that the fall is subject to constant variations, being steepest when the course of the lead is parallel to the greatest inclination of the country; any departure from this line will be attended with a diminution of the fall. A fair approximation to accuracy may be arrived at by drawing a line in the direction of the general fall of the country in the neighbourhood of the lead between two points on the lead of which the levels are known, *e.g.*, between the Vegetable Creek Company's old dam and Flannery's old shaft: the surface fall being in

a direction west 10° north, the distance between these two points measured on this line is 125 chains, and the fall 14 feet, *i.e.*, 1 in 58. From Flannery's to Barry's, a distance of 170 chains, the fall should therefore be 194 feet, subject to some reduction to allow for the slope diminishing as the distance from the source increases. This would make the deepest channel at Barry's 80 feet below the level of the bedrock on which the present lead is being worked. This is without allowing for the diminished fall. The fall from the source to the termination of the lead at the Fishing Grounds, measured along straight lines following the principal inclination of the country, is 900 feet in $12\frac{3}{4}$ miles = 1 in 74·8. Estimated at this rate Barry's gutter would still be 35 feet below Bailey's. The smallness of fall in the bottom between Hard Rock Shaft in portion 2, Hamilton, and the gutter at Bailey's (only 28 feet in a distance of $1\frac{1}{4}$ miles) also confirms the supposition that Barry's Gutter is not the main channel. Assuming that the bottom fall from the Hard Rock Shaft to Barry's is 1 in 66 (1 foot per chain) the bottom of the deepest channel here would be over 70 feet below the bedrock at Bailey's. As the gutter now has been well prospected across at Barry's from bar to bar, the conclusion naturally is that the deepest channel is between the inlier in portion 771, Strathbogie, and the north-east corner of portion 51, Hamilton.

"From this supposed level at Barry's to the Fishing Grounds, a distance of 9 miles, there would be a fall of 568 ft. = 1 in 83·7. At this rate the bottom of the Wesley Extended Shaft, 280 feet deep, would be only 30 feet above the deepest channel, should it underlie this point. On the Geological Map aneroid levels are given at numerous intermediate points, and the approximate depth below the surface of the deepest channel, should it underlie any of these points, can be estimated from the rates given above for the different localities, viz., a fall of 1 in 66 from Flannery's to Barry's, and 1 in 83·7 from Barry's to the Fishing Grounds. From the levels given it would appear that the depth of sinking between Barry's and the south-east corner of portion 172 should not exceed 200 feet. From here to Kangaroo Flat the depth will range from 200 to 300 feet. (*b*) With regard to the underground course of the channels in the unworked areas, channels of leads flowing over basalt bottoms are so capricious in their course that any attempt to predict their whereabouts would be futile. With reference to the deepest channel between Barry's and Gordon's cultivation paddock, the deepest channel will probably be found nearer the northern margin of the made country than the southern, as the belts of basalt joining the trunk lead from the south-west probably cover tributary streams which would have had a tendency to push the main stream towards the north-west. The confluence of the Graveyard Lead, in or below Gordon's cultivation paddock, would have the same effect.

"2. *The probability of the gravels in the unproved country containing a fair percentage of Tin.*—The richness of deep leads may be inferred:

(*a*) From that of the neighbouring creeks.
(*b*) From the character of the bar rocks.

(*a*) No stream tin has been found in the claystone gullies between Flannery's and Gordon's cultivation paddock in portion 18, Strathbogie. A little stream tin is to be found in Two-mile Creek, from where it passes on to the altered claystone in W.R. 72, to its junction with the Vegetable Creek. Hogan's shallow lead, near the last point, is a

guarantee that the deep country here has been fed with some tin. But below the junction with the Vegetable and Two-mile Creeks very little tin has been found in the palæozoic rocks skirting the lead. The rim rock south and west of the main Vegetable Creek Lead below Barry's is hidden by basalt as far as portion 913, Strathbogie. Here the rock is a quartz-porphyry or eurite, containing several thin veins of tinstone, $\frac{1}{8}$ inch thick; and in portions 19 and 20 is a vein containing tinstone, the cap of which is 10 feet wide in places. From here as far as portion 150, Arvid, the bar rock is granite and eurite, and the occurrence of stream tin in the sand at Mount Doubtful proves that these rocks are slightly stanniferous. From this point to the Fishing Grounds the bar rock is chiefly claystone, with occasional dyke masses of quartz-porphyry, but no payable stream tin has been found in the present gullies draining from them. As, however, the basalt between Strathbogie and the Fishing Grounds is over a mile wide, there may be areas of stanniferous eurite concealed under the lava and dust, especially near points of eruption, such as in portion 134, Arvid. The prospects of the richness of the lead from Bailey's to Kangaroo Flat are not, therefore, very encouraging. From Bailey's to Gordon's cultivation paddock, a distance of over 4 miles, as the bar rocks are barren, the richness of the lead will depend on the amount of tin drifted from the tin eurite, which ceases at Bailey's. At Barry's, 170 chains west of Bailey's, there is still sufficient tin in the gravel to make its working remunerative, provided the cost of baling is not heavy. Much of Barry's wash yielded 1 cwt. of ore per cubic yard, and the grains were fairly coarse, so that I think the lead ought to continue payable for another mile, even supposing it receives no accession of ore from the bar rocks and feeders on the south.

"Near portion 15, the probable confluence of the Vegetable Creek and Graveyard leads, payable patches of gravel may be expected, but the width of basalt here is unfavourable for prospecting. Between the inlier of quartz-porphyry, near portion 19, Strathbogie, and the bar rock to the north, the basalt has a width of only 15 chains. The main channel must lie here, but, if it be as narrow in proportion as the basalt, the stanniferous gravel may have all been swept out of it by the force of the current. A most favourable point for prospecting would be from the north-west corner of portion 913, in a north-easterly direction towards the north-east bar of the lead.

"*Produce of worked Areas.*—The Vegetable Creek deep leads, from their source to Bailey's, including Partridge's lead, have yielded over 6,000 tons of stream tin in a distance of 190 chains—a yield in round numbers of $31\frac{1}{2}$ tons per chain = 2,520 tons per mile. At Kangaroo Flat 909 tons of ore have been won in a distance of less than half a mile. It may be assumed, then, that the produce of ore here is equal to 2,000 tons per mile, and this is probably below the true quantity, as the ground has only been partly worked. If, therefore, a yield of 2,000 tons per mile be maintained between Bailey's and Kangaroo Flat, a distance of nearly 9 miles, the quantity of ore which may be won from the unproved ground would be roughly 18,000 tons. The estimate of 18,000 tons may, of course, be under the true quantity, as at Kangaroo Flat one channel only, probably an upper grade, has been worked, and, for reasons already stated, the deep lead country here must cover two channels. It may, however, be the case that here, as at the Surprise mines, the lower channel will not be as rich in stream tin as the upper.

"The approximate amount of ore in the unworked ground of the main trunk Vegetable Creek Lead, the Surprise Mines, and the 'Y' Water Holes Lead, according to the above estimates, would be: Vegetable Creek, 18,000; 'Y' Water Holes, 7,500; Surprise Mine, 500; total, 26,000 tons.

"This estimate does not take account of the Graveyard Lead or of Hall's Sugarloaf, for the yield of which there are not sufficient data upon which to form even an approximate estimate.

"*The Springs, Rocky Creek, and Ruby Hill Leads.*—The basalt covering these leads is divided naturally into two portions, the eastern being separated from the western by only a few chains of coarse river gravel near the north-west corner of portion 101, Hawthorne. The two masses of lava also come within 15 chains of one another at ¼ mile east of portion 15, Hawthorne, if, indeed, they do not join at this point. The surface is, however, so entirely covered by granite sand that the question can be settled only by sinking shafts or boring. The aggregate length of these two masses of basalt is 21 miles. Although there is a slight interruption in the continuity of the basalt, there is a continuous river channel connecting the gravels underlying the lava here. The levels, however, prove that it is impossible for one continuous lead to underlie the whole of the made country. Aneroid measurements show the gravel at Rocky Creek and Basalt Hills to be approximately on a level with Ruby Hill, the distances between this last point and the two preceding points being respectively 7¼ and 9 miles, consequently a water-parting must occur at some point intermediate between Rocky Creek and Ruby Hill. This probably corresponds with the present main line of water-parting between the Severn and Dumaresq Rivers, which crosses the parish of Lorne in a west-north-west direction. The basalt to the south of this line, in the parishes of Lorne and Lockerby, has been termed the Ruby Hill Lead. The continuity of the Rocky Creek and Springs Leads has not yet been demonstrated.

"At Rocky Creek there is evidence of powerful fresh-water action, as the gravel beds capped by basalt are from 6 to 20 feet in thickness, all the pebbles being well-rolled, the largest 10 inches in diameter. If this shingle were laid down by a river, as seems probable from the occurrence of leaves in the tributary called the "Gem," then this watercourse must have some outlet. I have not succeeded in discovering such an outlet, and cannot at present explain the phenomenon.

"*The Springs Lead*** is the name given to the belt of basalt extending in a southerly direction from the Cockatoo for a distance of 8 miles. The width varies from 20 chains to 2 miles, and, from the way in which the basalt is confined between bar rocks, there can be no doubt that it covers the site of an old watercourse, perhaps an early representative of the Swamp Oak Creek. The main line of water-parting between the Severn and Dumaresq Rivers crosses this lead diagonally at a point 4 miles south of Cockatoo; so that, if a corresponding water-parting exists underground, the lead must be divided at this point, part flowing south into the parish of Astley, and part north by way of the Springs to "Cockatoo." I think the Springs Lead proper takes its rise somewhere near the boundary between the parishes of Astley and Athol, in which

* The Springs Syndicate (M.L's. 143–147, Parish Hawthorne, County Arrawatta) was engaged reopening this lead in the latter part of 1910. Wash was struck at 95 feet in tunnel, estimated to yield 40 lb. per cubic yard from the bottom wash, which varies up to 3 feet thick.

case its length would be about 6 miles. The bar rocks from this point to the termination of the lead are chiefly quartz-porphyry and granite. No stream tin has been worked in the gullies draining the bar rocks, nor have any tin veins as yet been discovered in them. The first point where an outcrop of gravel is seen is at the Springs, near the south-east corner of portion 34, Hawthorne. A tunnel has been driven into the basalt by Mr. Wheeler, which has cut gravel and sand from 1 to 2 feet thick. The wash consists of clean quartz sand, well-rolled pebbles of clear and dark quartz, black quartzite, and claystone, some of the last being 6 inches in diameter. The grains of stream tin, chiefly black, average $\frac{1}{50}$ inch in diameter. At Cockatoo, $\frac{3}{4}$ mile northerly from the Springs, in portion 30, Hawthorne, is another outcrop of coarser gravel, composed of well-rolled pebbles of quartz, chiefly dark, and blocks of quartz-porphyry and claystone, up to $1\frac{1}{2}$ feet in diameter. The alluvials at both these outcrops are just rich enough in stream tin to pay expenses and leave a small margin for profit. The quantity of ore raised from a very small area, which has only been partly worked, is about 30 tons. The lead has been very little prospected, the surface indications being here unfavourable to the occurrence of rich gravel; though it cannot be doubted that gravel containing stream tin in small quantities underlies the greater part of the lead, and may be worked to advantage if the lead proves tolerably dry. In prospecting this lead, the miner should be on his guard against mistaking the rubble of quartz-porphyry overlying the basalt for the true bedrock. This rubbling over of the lead is most noticeable near the slip-rails in the wire fence 50 chains north of the north west corner of portion 2, Athol.

"*Rocky Creek Lead.*—The tertiary country embraced under this name extends from Cockatoo to the water-parting between the Severn and Dumaresq Rivers, in the parish of Lorne, a distance of 9 miles. There are at least two grades of gravel here, the upper grade resting on top of the basalt, 120 to 140 feet above the lower grade. Outcrops of gravel occur on this lead at Basalt Hills, Rocky Creek, near the north-west corner of portion 101, Hawthorne, at the Gem in portions 38 and 39, Lorne, and near portions 48 and 52, Lorne. The outcrop at Basalt Hills and the bottom of the channel near portion 101 are nearly on a level, while the others are from 40 to 70 feet higher. At the Basalt Hills the gravel has been tested by several shafts and two tunnels. The alluvial beds are composed chiefly of fine quartz sands such as result from the waste of quartz-porphyry (containing numbers of beryls), with pebbles of claystone up to 1 inch in diameter. The beds are 3 feet thick, containing stream tin in barely payable quantity, with colours of gold. The tin ore is black with some resin and ruby, and is coated with brown iron oxide. The grains, some of which are very sharp, average $\frac{1}{50}$ inch in diameter.

"At Rocky Creek a good deal of prospecting has been done by Messrs. Colgan and others in the deep lead ground. The result of their explorations shows that the deepest ground lies in the narrow valley between the claystone hills near the north-west corner of portion 101, Hawthorne. A coarse gravel was struck here under the basalt at depths varying from 40 to 70 feet. The alluvial deposit, which was chiefly composed of well-worn quartz sand, claystone, and black felspathic quartzite, was from 3 to 20 feet thick, and yielded from 10 to 15 lb. of ore per cubic yard. The lead here has a north-west and south-east course for 1 mile, when it becomes lost under the great mass of volcanic material which has been

ejected from The Gap volcanoes. Where the lead is split by the island of claystone east of portion 17, Lorne, the deepest ground probably underlies the eastern loop of basalt. A natural section of the gravels may be seen in the bed of Forest Creek. The gravels at this point are 19 feet thick. Colours of gold were got in nearly all the shafts.

"The Gem Lead has been proved to be a rich feeder, falling into the main body of basalt from the north-east. The commencement is in an outlier of quartz sand and gravel, capped by basalt, in portion 38, Lorne. From here the lead has been swept away to the south for a distance of 15 chains. Then it makes its appearance again, outcropping from the north-east end of a spur of basalt. From here it has been worked by Messrs. Colgan and others for a distance of $\frac{3}{4}$ of a mile, the channel being from 10 to 62 feet wide, averaging 15 feet in width; and the alluvials consisted of pipeclay and magnesite, the former containing fossil leaves, overlying well-worn quartz sand and small pebbles of quartz-porphyry. The wash was from 3 inches to 2 feet in thickness, averaging 6 inches, and yielded 70 lb. of ore per cubic yard. The richest yield here was 3 tons of stream tin from 70 cubic yards of wash. Emeralds and sapphires are associated with this stream-tin. At Colgan's 54-feet shaft on this lead, near the south-east corner of portion 52, Lorne, an upper run of stanniferous sand and gravel was struck at 5 feet below the surface; and just east of the middle of the east line of portion 49, Lorne, a still higher level gravel was worked on a basalt bottom. This patch, which was 9 feet thick and rich in stream tin, shows at the surface for only 1 acre. The superior richness of the Gem as compared with the coarse river gravel in the trunk lead is partly explained by the occurrence of thin veins of tinstone in quartz in portion 39, Lorne, near its commencement. Near portion 48 the outcrop shows the tertiary alluvials to have a thickness of 14 feet, the natural section showing pipeclay overlying quartz sand, which passes downwards into gravel of worn quartz pebbles, the whole being capped by hard basalt. At the outcrop, north of portion 52, similar sands yield 4 lb. of ore per cubic yard. In Salmon's shafts, 30 chains south-south-west of the south-east corner of portion 4, Lorne, worn quartz sand and subangular fragments of quartz, with a little tin were obtained beneath rotten basalt and laterite, at 78 feet from the surface. The depth of the volcanic rock here may be inferred from the fact that in portion 35, Lorne, a shaft was sunk by Kelly and party, 207 feet deep, without reaching the bed rock.

"*Ruby Hill Lead.*—The source of this lead probably lies near the present main line of water-parting, so that from here to its southern extremity at Ruby Hill the lead has a length of 5 miles. The width of the volcanic formation varies from 5 chains to 2 miles. The most important outcrop of gravel is at Ruby Hill, where the tertiary alluvials are from 10 to 15 feet thick and 5 chains wide. The constituents are lenticular beds of sand and gravel. In places pipeclay intervenes between the sand and basalt. The sand, which is red and white, is mostly cemented by felspathic material. The constituents of the gravel are well-rolled pebbles of clear and opaque quartz, red and black jasper, and pebbles of quartz-porphyry, the last attaining the diameter of 1 foot. Zircons and sapphires are plentifully intermixed with the stream tin. The latter is very fine, the grains being $\frac{1}{7}$ inch in diameter. It is a remarkable fact that in spite of this excessive fineness a large proportion of the grains when examined under the microscope are seen to consist of well-formed crystals with sharp edges. As no veins of tin-stone are

known to occur in the rim rocks of this lead, the inference to be drawn from this is, that the tin has been disseminated in these fine crystals through the mass of the quartz-porphyry, from the waste of which these alluvials have been formed. Eighty tons of tin ore have been won here in a space of about 2 acres. The quality of ore is, however, very inferior for smelting purposes on account of the inevitable mixture of gem stones, even after careful cleaning of the ore, their high specific gravity rendering their entire removal practically impossible. Another outcrop of the lead may be seen at a point 10 chains south-east of portion 39, Lockerby. A number of shafts were sunk here on to a drift of quartz sand and quartz pebbles, the latter up to an inch in diameter. The conclusion to be drawn from the facts mentioned of the occurrence of extensive beds of sand and gravel at levels varying little over an area 14 miles long, suggest a marine origin for the beds. The occurrence, however, of leaves of land plants in the pipeclays overlying the gravel is opposed to this view.

"*Prospects of the Rocky Creek and Ruby Hill Leads.*—The rim rocks on either side of the lead from Cockatoo to Ruby Hill are not known to contain veins of tin-stone, with the exception of a few insignificant leaders in portion 39, Lorne. No payable stream tin has been found in the gullies draining the rim rocks. The example, however, of Ruby Hill shows that even where vein tin is absent, or too far distant to have fed a lead, and no payable tin has been found in recent deposits neighbouring, deep leads may be payable, owing to the presence in them of stream tin originally disseminated in fine crystals through the mass of the rim rock, and subsequently concentrated by prolonged denudation. The greater part of the gravels underlying the basaltic country, between "The Springs" and Ruby Hill, will be poor in stream tin as compared with the Vegetable Creek lead. The country has not been worked on a sufficiently large scale to justify a definite estimate of the average yield of the gravel. The production of 80 tons at the Ruby Hill Mines in a length of about 5 chains proves that the quantity of ore in these leads must be reckoned by many thousands of tons. Although the deepest ground at Rocky Creek does not contain stream tin in payable quantity (12 lb. per cubic yard may be taken as the average), richer upper level alluvials may be expected at intervals, the older deposits containing more tin than those of later geological age, as proved at the Surprise Mines, Scrubby Gully, Surface Hill, &c."*

"By far the most important deposit of this class (bare, not covered with basalt.—J.E.C.) is that known as the 'Y' Water Holes and Graveyard Lead. This formation, consisting of laminated pipeclays and red current-bedded sand, has an area of 1 square mile 450 acres, and a depth of from 10 to 60 feet, the average depth being 20 feet. The nature of the clay and sand beds forming this deposit is shown on Fig. 1, page 40.

"Few pebbles are found at the 'Y' Water Holes, but traced towards the Graveyard the pebbles increase in size and number. In the Vegetable Creek Company's Mine at the Graveyard they are 1 foot in diameter. At the 'Y' Water Holes the sands are composed of irregularly shaped subangular grains of dark quartz, $\frac{1}{4}$ inch in diameter, such as may have been derived from coarse granite. Associated with these are a few intensely worn polished pebbles of reef-quartz, $\frac{1}{2}$ inch in diameter. The cementing medium is red peroxide of iron and clay.

* Geol. Veg. Ck., 1887, pp. 96–107.

"Most of the stream tin is fine, averaging $\frac{1}{30}$ inch in diameter; the grains are well worn. In portion 58, parish Scone, however, the tin is coarser and more angular, fragments $\frac{1}{2}$ inch in diameter being of common occurrence. Zircons, locally called "brass filings" or "green tin" titaniferous iron ore, spinel, and magnetite are mixed through the gravels, and on account of their high specific gravity are difficult of separation from the tin-stone.

Distribution of Ore.

"Vertical sections show that the stream tin is almost entirely confined to the sand beds, and is most abundant at their base within a distance of from 2 to 3 feet above the rock, and at the surface, for a foot or so downwards. The intermediate sand, though poorer in ore, yields from 6 to 7 lb. per cubic yard.

"The richness in ore of the base of the beds is obviously due to the high specific gravity of the tin-stone, causing it to work its way through the lighter quartz sand on to the bed rock.

"The surface is richer in stream tin than the intermediate beds, owing to its having received the tin from sluicings of a considerable thickness of sands once overlying, but subsequently removed by denudation. As regards the horizontal distribution of ore, no definite channel has been found in the outlier on the east side of the 'Y' Water Holes, the ore being disseminated all through the base and surface of the beds without being concentrated in a channel, the deposit probably being lacustrine. West of the 'Y' Water Holes a defined channel has been worked by O'Mara, in portion 1, parish of Scone, and followed by Murgatroyd in portion 58, Davidson and Gibson in portion 61, Kirker in portion 63, and David Lewis in portion 75. At O'Mara's workings the channel was from 30 to 130 feet wide, and the tin-bearing gravel, chiefly clean white sand, from 7 to 8 feet thick. A small feeder was followed here coming in from the north-east. At Murgatroyd's the pay channel was from 20 to 80 feet wide, and the pay gravel from one to 2 feet thick, yielding from 30 to 40 lb. of ore per cubic yard. The wash from the north side of portion 58, in which this mine is situated, contains coarse grains of tin-stone up to $\frac{1}{2}$ inch in diameter, some sharp, the average diameter of the tin grains being $\frac{1}{60}$ inch. In portion 61 two channels have been worked. The tin in the south channel was coarser than that in the north. At Davidson's and Gibson's the lead was about 140 feet wide, the wash averaging from 2 to 3 feet thick, but in places 7 feet, and yielding 40 lb. of ore per cubic yard. At Kirker's the gutter was 80 feet wide, the wash from 2 to 5 feet thick, yielding 28 lb. per ton. At David Lewis's a small patch of clayey gravel, containing small pebbles of quartz-porphyry, has been worked at 50 feet below the surface, but it is doubtful whether this is on the same channel as Kirker's. There is a steady fall in the surface of the bed of the rock underlying the tertiary beds from *a* 1 shaft to *e* 5, amounting to 10·70 feet in a distance of 60 chains.

"The lead, which has been proved at intervals up to this point, has been lost here; and as the present water-parting between the Severn River and Glen Creek runs a few chains to the west of this last shaft, it may be the case that a similar water-parting exists underground in the bedrock shutting off the 'Y' Water Holes from the head of the Graveyard Lead. A new lead has recently been discovered to the north-west of this water-parting, and apparently distinct from the 'Y' Water Holes

Lead. Certainly the upper end of this gutter can have no connection with the tin wash proved at *e* 5, as shown by the levels; besides, the sands in the Race-course Lead are white, like those at the Graveyard, while the bulk of the 'Y' Water Holes sands are red. Red sands, however, do exist in the Graveyard Lead [See Vertical Sections at Casley's Shaft], and clean white sands are found at O'Mara Shaft, &c., at 'Y' Water Holes. As regards the difficulty of levels, the surface of bedrock at B.B. is sufficiently low to have let through the lead lost at *e* 5. It is still possible, therefore, that there may be a narrow opening through the bar between *e* 5 and BB, connecting the two leads. In this case the lead heading from F must be a feeder. For the sake of convenience, however, the line of water-parting may be taken as the western boundary of the 'Y' Water Holes Lead. The mass of stanniferous sand included within the area of the 'Y' Water Holes Lead, as so defined, has a superficial area of about 300 acres. The richer patches of gravel, averaging 35 lb. of ore per cubic yard, have been practically exhausted; but estimating the average thickness of sand at 6 feet, and the average yield at 6 lb. per cubic yard, the total quantity of ore contained in these 300 acres would amount to over 7,500 tons.

"*The Graveyard Lead.*—The rich tin gravels in this lead have a more defined shape than those at the 'Y' Water Holes, evidently having partly been formed along the bed of a silted-up watercourse. The Race-course Lead probably marks the source of the main channel, which, rising from the north-east corner of portion 69, Scone, flowed in a south-westerly direction parallel with the present Graveyard Creek. At the source, the tin gravel is 12 feet below the surface, increasing to over 40 feet within a distance of $\frac{1}{4}$ mile. A continuation of the channel has been worked by Proctor, in portion 532, parish of Scone, for a distance of 10 chains, 9 tons of ore being won; then for a space of 25 chains the lead has been lost, but the gutter has been proved again in portion 534, parish of Scone, for a distance of 2 chains, by Louis Webb and party, then lost for 20 chains, until portion 195, parish of Scone, is reached, where the lead has been worked for several chains by Francis and party. At this point, a branch lead or feeder junctions with the main lead, falling in from the north-east. This feeder has been worked for a distance of 13 chains, and consisted of quartz sand, round and subangular, the grains having the shape of double hexagonal pyramids, a few well-rolled pebbles of quartz $\frac{1}{4}$ inch in diameter, and angular fragments of quartz veinstone containing tin-stone. At Francis' workings on the main channel, the stanniferous wash was composed of quartz sand derived from the water-worn blocks of the same rock up to 1 foot in diameter. The wash was from 3 to 6 inches thick. The stream tin, chiefly well worn, is decidedly coarser than that at the 'Y' Water Holes, the grains averaging $\frac{1}{20}$ inch in diameter. West of portion 195, in portions 202, 200, 199, and 198, the lead has been extensively worked at the old "Graveyard Mine" by the "Vegetable Creek Tin-mining Company," then by tributors Casley, Curtin, Fontana, &c. The width of the payable gravel here was from 1 to 4 chains, and the thickness of the pay drift from 1 to 4 feet, averaging 2 feet thickness, and yielding an average of 38 lb. of tin per cubic yard. The stanniferous drift consists of fine, very clean quartz sand, the quartz occurring in rounded and subangular doubly-terminated crystals, with a few well-rolled tertiary quartz pebbles $\frac{1}{2}$ inch in diameter, and in the centre of the channel blocks of quartz-porphyry over 1 foot in diameter. The tin is chiefly well-worn and

black, $\frac{1}{40}$ inch in diameter. Zircons, sapphires, titaniferous iron, spinel, and magnetite are plentifully intermixed with the tin ore. At the old Graveyard workings the sedimentary beds are capped by laterite, from 27 to 40 feet thick, making the depth of sinking, from surface to bed rock, over 100 feet, so that at this point the bare deposit merges into a deep lead. An outlier of laterite has already been passed over in portion 197, Scone; and traces of volcanic dust extend from portions 63 to 73, Scone, showing that any hard and fast line drawn between bare and covered deposits would be merely arbitrary.

"2. *Tertiary deposits capped by Lava.*—As the stanniferous sand worked in the Graveyard mine is traced under the laterite, the character of the deposit becomes rather complicated. A deep channel with coarse water-worn blocks of quartz-porphyry continued on in a west-south-west direction, and has been proved near the south-west corner of portion 200, Scone, in a shaft 110 feet, and also in portion 520, Scone, at the south end of the portion, in a shaft 130 feet deep. The coarse gravel, however, in this deep ground, did not contain stream tin in payable quantity. Lately, however, a continuation of the coarse gravel has been found to be payable in some shafts sunk near the south-east corner of portion 200, Scone. The richer portion of the sand and gravel was found to extend in a south-west direction, at a level some feet above that of the main channel. At a shaft sunk by Casley, 49 feet deep, in portion 199, Scone, the wash was patchy up to 2 feet in thickness, and consisted of fine, clean quartz sand, with large water-worn blocks of quartz-porphyry, the tin well-worn and black, in grains about $\frac{1}{40}$ inch in diameter. The yield of ore was 44 lb. per cubic yard. The locally cemented masses of stanniferous sand here, called 'grey clinkers,' have already been described. A similar tin-drift was worked by Curtin and Fontana in the adjoining portion 200. At Curtin's, a seam of payable wash, with quartz pebbles 3 to 4 inches in diameter, and clay balls, was found at 11 feet above the bedrock. The wash on the bed rock was very uneven and patchy, from 6 inches to 3 feet thick. West of Curtin's the lead has not yet been satisfactorily proved. A second feeder has been worked in portion 520, Scone, and a third at Ceruti's spur at the south ends of portions 133 and 134. The stream tin from the latter is decidedly coarser than that in the main lead, averaging $\frac{1}{14}$ inch in diameter; is black and intensely worn. Both these feeders have a fall in a southerly direction towards the centre of the tertiary beds, but as yet prospecting has failed to reveal their points of junction with the main lead. The shaft, sunk 130 feet deep in portion 520, Scone, is certainly close to, if not actually in, the main channel, as is proved by the coarse water-worn blocks and steep slope of the bed rock towards this coarse gravel. A hard bar, either a dyke mass or an old bed, strikes through the bottom rock here, apparently in a direction roughly north and south. This may have contracted the lead, and so produced a current of water sufficiently strong to sweep the tin out of the channel. At a point 32 chains westerly from the 130-feet shaft, a prospecting shaft has been sunk by Hurley and Conlon, subsequently bottomed by Casley and party at 124 feet. Coarse red sand 32 feet thick, as shown on section No. 3, was passed through in the upper part of the shaft, and at 44 feet from the surface hard basalt was met, this being the furthest point east on this lead to which the last-named rock has been proved to extend. This shaft was bottomed on claystone, there being a thickness of 9 feet of water-bearing sand next to the bed rock. Red sands similar to those in the upper

part of the preceding shaft may be seen outcropping from under the laterite, wherever it has been cut through by gullies, as along the east line of portion 526, towards the south-east corner. On the east line of portion 525, Scone, a line of shafts have been sunk, which prove that that the tertiary beds are thickest, and the made ground deepest near the south-east corner of portion 525, Scone. Three shafts have been sunk here in hard basalt to depths of 97, 101, and 103 feet respectively, but I was unable to ascertain whether any of them had been bottomed, no sand being visible in the spoil banks around the mouths of the shafts, and their sides having fallen in. The true channel probably lies between the 97-feet shaft and a point some few chains south of the south-east corner of portion 525. The trend of the gutter west of this point is still more doubtful. An inlier of bottom rock shows at the surface in portion 517, Scone; the ground between this and the bottom rock in portion 524 has the appearance of not being very deep, and the main line of water-parting runs about 15 chains to the south. The deepest channel here will, therefore, probably lie to the south of this outlier. West of this point the prospecting has been carried on in portions 516 and 512, Scone, Kennedy's and Reynold's selections, respectively. Several deep shafts have been sunk in Kennedy's selection, which have proved (1) that an upper layer of sand, said to contain stream tin, overlies the hard basalt here as at Hurley's shaft, and (2) that a branch lead enters the north-east corner of Kennedy's selection, falling from north-east to south-west, and underlying hard basalt 100 feet thick. This branch lead was originally supposed to be a continuation of the Vegetable Creek Tin-mining Company's original deep lead. Subsequent underground workings, however, tend to show that this is not the case, for

"1. The only two possible openings in the bedrock have been well prospected, and yet show no made ground sufficiently deep to have let through the Vegetable Creek Lead. A series of shafts have been sunk across the first of these gaps, on the last line of portion 148, Scone, from 7½ to 29 feet deep, all said to have been bottomed on to bedrock. The bedrock at the deepest point here is exactly on a level with the bed of the channel in the 83-feet shaft, in portion 718, Strathbogie North, 55 chains distant, and for a similar distance above this point the fall in the channel is 35 feet. Such an extent of level rock in the bed of a creek is unprecedented, so that the lead cannot have forced its way through this channel. The second opening in 547, Strathbogie North, must be discarded as a possible outlet for the main lead for similar reasons, the level of the bedrock being too high.

"2. The main channel of the Vegetable Creek Lead, as shown on the plan, has been proved to the north-west for a distance of 1 mile past these strips of tertiary country. The character of the tin gravel in the branch lead very closely resembles that in the Vegetable Creek main lead, containing numbers of dark pebbles of opalised wood (black quartz) specially characteristic of the latter lead. Good coarse angular tin was found at the south-east corner of portion 129, Scone, in a shaft 75 feet deep; the stream tin gravel was a hard cement composed of sand grains agglutinated by felspathic material, and from 5 to 6 inches thick, while the channel was about 1 chain wide. The probability is that a low line of water-parting existed

previous to the volcanic period, separating the Vegetable Creek from the Graveyard lead, the position nearly corresponding with that of the present water-parting between the two creeks In times of heavy flood it is conceivable that a powerful body of water, rushing down the old channel of the Vegetable Creek Lead, would overflow the lowest points in the watershed at the sharp turn in portion 718, Strathbogie North, and perhaps even carry with it some of the tin swept from the bottom of the channel. Webb's workings south-west of this bend showed that the tin had been swilled up in this manner to a height of 10 feet above the bottom of the channel, as wherever large pebbles were found in Webb's Gutter the stream tin was invariably found chiefly on the south-west side of the stones, showing that the currents which dropped it were flowing from the north-east. This branch lead may therefore be regarded as a tributary of the Graveyard Creek, perhaps corresponding to the present Sheep Station Gully, and taking its rise on the southern side of the water-parting between the Vegetable and Graveyard creeks, and occasionally, perhaps, through a pass in this water-parting, forming a discharge channel or by-wash for the flood-waters of the Vegetable Creek. The point at which this tributary or feeder joins the main Graveyard lead probably lies somewhere near the south-west end of Kennedy's selection. Unfortunately there is considerable uncertainty as to the depths of some of the shafts in Kennedy's selection, the shafts having fallen in, and no record of the original depth having been preserved. The shaft said to have driven on wash at 80 feet from the surface is variously stated as being 129½ feet and 156 feet, and the character of the sinking was given as follows, from the surface downwards:—

72 feet	...	Laterite. Rotten olive-green basaltic soil.
8 ,,	...	Fine white sand, cemented with fine tin, like that at the Graveyard, resting on sandy pipeclay.
49½-76 feet...		Dense dark green basalt.

At the point shown on the plan at the north end of portion 516, stream tin was got in a shaft at 8 feet from the surface, on a bottom of felstone, the thickness of the tin cement here being from 1 to 1½ feet. The stanniferous cement cut in the preceding shaft may therefore have been a continuation of this shallow wash. At Reynolds' selection, joining Kennedy's on the west, a number of deep shafts have been sunk. Going westerly, the first deep shaft, 156 feet deep, was bottomed on granite, the shaft being sunk through laterite and friable dark green basalt. No sand or gravel between the basalt and the granite bottom was met with. The next shaft, 195 feet, was sunk through laterite and friable basalt into pebble beds saturated with water, the water preventing the shaft being bottomed on the bedrock. These pebbles exactly resemble those in the Upper Silurian, pebble conglomerates forming the rim rock of this lead at the south-east corner of portion 180, Scone, and are therefore probably derived from this source, and

do not necessarily indicate the proximity of the main channel. In H. Jew's shaft, 12 chains north-west, 220 feet deep, black clay with fossil leaves and cemented sand were struck under the basalt. As soon as the cement was broken through, the water in the underlying sand boiled up strongly, and all efforts to bale it down failed. Ten chains north of Jew's shaft, a shaft was sunk by Flannery, and attempts were made to keep the water under in the fine-running sand by means of a Tangye plunge and lift pump, but as each layer of cemented sand was broken through in the course of the sinking the influx of water became stronger, and the pump being inadequate for the work the undertaking was abandoned. No steam tin, as far as I am aware, has been found as yet west of Kennedy's.

Summary.

"From the north-east corner of portion 69, Scone, to the old tramway shaft in portion 201, Scone, a distinct silted-up channel has been proved at intervals, having a fall in its bottom of 68 feet in a distance of 130 chains. Out of this distance about 40 chains have been worked. A considerable quantity of ore is probably contained in the poorer sand here as at the 'Y' Water Holes lead, but there are not sufficient data for estimating its quantity. From the presence of coarse tin and tin-bearing veinstone in the feeder in portion 194, it is evident that the tin ore has been derived from the range of hills 1½ miles to the north, from which this tributary creek took its rise. The northern side of the sands should therefore prove richer in stream tin than the southern. West of the Graveyard there is evidence of a double lead, the upper one consisting of the red and white sands, which at Hurley's and Kennedy's shafts are capped by laterite and overlie basalt; the lower level composed of white sand and gravel, separated at Hurley's shaft from the red sands by a wedge of basalt. This wedge, as shown on Section No. 4, H–I, thins out in an easterly direction so as to bring the upper and lower runs together, while westerly it probably thickens. Possibly the upper seam of tin wash at Curtin's shaft marks the line of separation between the two runs. In any case an upper run of sand must extend between the laterite and the basalt, at least as far west as Kennedy's, and theoretically should skirt the northern margin of the hard basalt, and should lie accordingly between Hurley's shaft and Ceruti's spur. My attention was called by Mr. A. Cadell to the fact that the proximity of an underground channel is often indicated by the outcrop amongst the sand beds of a seam of cement, the sand being glued together by silicates and oxides of iron; patches of such cemented sandstone occur at the points indicated in portion 522, especially at the north-west corner, and it might be as well to prospect the ground here for the upper lead in a south-east direction, to catch the lead below the junctions of the second and third feeders. It is strange, however, that such a shallow lead, if it exists, should not have been struck in the series of shafts sunk along the eastern line of portion 525, Scone.

"As regards the lower level lead the prospecting shafts show that between the rope straining shaft in portion 201, Scone, and the 130-feet shaft in portion 520 there is a fall in the surface of the bed rock of 69½ feet in a distance of 27 chains; that is more than twice the normal fall of the deep leads, which is 1 foot per chain. Under such circum-

stances there would be little chance of deposits of tin being retained on the bedrock in any quantity between these points; but further west, along the east line of portion 522, there should be some payable patches.

"Another favourable locality for prospecting would be about the centre of Kennedy's selection, where the junction may be expected of the fourth feeder with the main lead. As regards the probable depth of the channel from the surface, if it should underlie this point, inferences may be drawn from the following data. At Hurley's shaft, 45 chains westerly from the 130-feet shaft, the surface of the bedrock is 31 feet below that of the latter, and probably this is not much above the bottom of the true channel. Taking the level of the channel here as 2,830 feet above sea-level, allowing a fall of 1 foot per chain from here to the centre of Kennedy's selection, a distance of 80 chains, the level of the channel should, if underlying this point, be 2,750 feet; and taking the surface level at 2,950 feet, the depth of sinking would be 200 feet; and if the channel lies nearer the south-west corner of the portion the sinking would be from 20 to 30 feet deeper. By the same method of calculation the depth of the channel, should it underlie the 195 feet, 220 feet, or 170 feet shafts in portion 512, would be respectively 268, 312, and 238 feet, giving a thickness of sedimentary material of 73, 92, and 113 feet respectively. In the Vegetable Creek lead, in portion 2, Hamilton, a corresponding distance from the source of the lead, the thickness of sedimentary material has been proved to be 79 feet, so the above estimate may not be excessive.

"As very little surface tin has been found on the rocks fringing the lead west of Kennedy's, until portion 726, Strathbogie, is reached, it might be advisable to prove the existence of a payable lead between the Graveyard and Kennedy's, the rim rocks between these points being known to contain tin-stone, before prospecting the areas still further west, the stanniferous nature of which is more doubtful. The fact, however, that granite underlies the volcanic hills in Reynolds' selection, the bar rock, being claystone, is favourable to the occurrence of leaders of tin-stone, and consequently there is a chance of the lead having been fed with stream tin at this point.

"From Reynolds' selection the belt of laterite and basalt 1½ miles wide sweeps west-north-west for 2½ miles to portion 15, Strathbogie South, where its confluence take place with the Vegetable Creek Lead probably in that portion, though two possible connections can be traced higher up the lead in portions 737 and 739, Strathbogie, respectively. Prospecting shafts and drives have been made in the tertiary country at the Pipeclay Gully, near the south-west corner of portion 12, Strathbogie; and a well-worn stanniferous quartz sand and gravel has been prospected 5 chains south-east of the north-east corner of ¾ Strathbogie at a point where it outcrops from the side of a small hill of laterite. The gravel at this point did not contain tin in payable quantity. A few worn tertiary iron-stained quartz pebbles are found at a point about 30 chains north 17° west from the south-east corner of portion 20, Strathbogie. The gravels to which they belong, like those in the preceding outcrop, may belong either to feeders of the main Graveyard lead, or to old tributaries of the Severn River, having no connection with the Graveyard lead.

"*Rim or Bar Rock.*—As the stream tin in the tertiary beds is chiefly derived from the palæozoic rock, which formed the watersheds draining into these old streams and lakes, it follows that an examination of the

rim or bar rock often enables the observer to form a tolerably accurate estimate as to the probable richness in stream tin of an unproved lead. The best estimate of the tin-bearing character of a bar rock may be gathered from a study of the gravels and sands in the creeks and gullies draining from it. If these contain stream tin in payable quantities the neighbouring deep lead may reasonably be expected to be payable, and *vice versâ*. At the 'Y' Water Holes there is evidence of the tin having been derived from the range of quartz-porphyry hills to the north, and the richness in tin of the tertiary sands here might safely have been predicted from the quantity of stream tin near the sources of the 'Y' Water Holes and Graveyard Creek. The Graveyard Creek contained payable tin from its source downwards for a distance of 3 miles to portion 139, Scone; but as soon as it left the quartz-porphyry for the claystone, the creek gravel became poorer in tin-stone. The claystone rock is therefore not favourable for stream tin, and leads cut through this rock are not likely to contain rich deposits of ore. The bar rock of the Graveyard lead is composed of this formation for over 3 miles west of portion 180, Scone, and as no payable tin has been found in the present gullies draining its surface, the lead cannot have been fed with tin along its north margin. The south bar of the Graveyard lead is composed principally of quartz-porphyry and felsite, apparently not rich in vein tin, as no payable deposits of ore have as yet been discovered in the recent alluvials where this formation obtains, between 'Y' Water Holes and Pipeclay Gully. The example of Ruby Hill, however, shows that a lead may contain payable tin even when the surrounding recent deposits are not payable, the tin-stone in this case probably having been disseminated in fine crystals through the mass of the rock. The discovery of fine stream tin in the tertiary gravels in M. L. $\frac{2}{4}$ proves that these quartz-porphyries must be to a certain extent tin-bearing. The inlier of similar rock in portion 736 and 19, Strathbogie, contains several thin veins of tin-stone, so that there is a probability of the lead having been fed at this point. The greater part of the rim rock may therefore be regarded as tin-bearing to a limited extent, and where the bar rock is not tin-bearing there is still the possibility of the presence of drifted deposits of detrital ore, as it has been proved in this district that stream tin can be swept for a distance of at least two miles from its source.

"The yield of tin ore from the worked portions of the 'Y' Water Holes to the Graveyard, a distance of $3\frac{1}{2}$ miles, offers a rather encouraging prospect for the unproved portion of the lead. This has a length of 5 miles. The unproved lead west of the Graveyard will be difficult to find on account of the width of the volcanic country, and when found, the channels, though probably not rich, will contain large patches of gravel which may pay working expenses when the price of tin is good."*

1. *Are tin leads likely to be payable for long distances?*
2. *What distance will tin sand travel down stream from its source when the fall is very gradual?*

These questions persistently recur when the lower reaches of basalt covered leads are under consideration. On correct solution depends justification for costly testing of old channels (defined approximately by basalt cover) at considerable distances below the source of the stream.

These questions lead to two others. (*a*) Does the channel traverse stanniferous rocks along its course, or receive tributaries from such? (*b*) or does it leave them near its head?

* Geol. Veg. Ck., 1887, pp. 72-84.

In the former case, the lead would be receiving continuous contributions along its course; in the latter, it would be entirely dependent on the distance and amount of transport.

The distance tin ore—in appreciable quantity—will travel down stream from a given point, depends on abundance of supply, fineness of particles, and the fall of the stream; and these again upon frequency of abnormal floods, for it is doubtful if normal stream flow will transport beyond comparatively short distances from the source of supply.

Normal stream flow keeping its sand bed "lively" enables particles of high specific gravity, like cassiterite, to speedily work to the bedrock, and there become more or less protected by the overburden of sand, only the upper layers of which would move perceptibly save in times of flood and scour.

Where a channel, such as the early Vegetable Creek, becomes sealed over with lava without entirely filling its valley or altering the course of the drainage, fresh contributions of tin-bearing gravel and sand may be laid on the basalt cover of the buried lead, and these in turn overwhelmed by later lava flow. The richness of the superincumbent drifts will be proportional to duration of denudation and transport between the volcanic extrusions, and to the area of stanniferous rocks exposed, for it follows that the filling of the valley diminishes the area of the watershed subject to denudation.

In the case of Elsmore and Newstead Deep Leads, where the source of the tin supply is circumscribed in a small area of granite, more or less completely surrounded by non-stanniferous rocks, the major portion of the exposed granite mass was degraded, and its tin burden concentrated in the heads of the early channels (abovenamed) prior to their partial filling with flood debris, chiefly from the predominant non-stanniferous rocks. Above the thick deposits of sediments and rock waste thus accumulated, stream action resumed its normal flow, depositing fresh sands and gravels in which the tin contents were proportional to the diminished area of granite exposed, and the limited time of denudation and transport prior to the extensive lava flow, which completely filled the valley, and left only the present small granite outcrops of Elsmore and Newstead above its enwrapping embrace, to the operation of denuding agencies.

Though the probability of transport of tin for a distance in payable proportion in the above leads, is discounted by the limited source of supply, yet there is undoubted encouragement to persevere beyond the furthest extension of workings to date, where rich deposits of tin were obtained.

The Stannum Vale Deep Lead is another instance of limited transport when the source is circumscribed, and the tin supply limited at the immediate head of the stream. Unlike the past or present Vegetable Creeks, the head of the Stannum Vale channel was never very rich, nor are the rocks it traverses tin-bearing beyond a trifling distance below its source.

In the present deep test shaft in portion 95, parish Wellington Vale, down the basalt-covered course of the old valley, a large stream bed has been located, filled with drift sand and pebbles, and numerous large boulders on the bedrock, yet only the smallest trace of extremely fine tin particles has rewarded prolonged and persistent efforts in sinking and driving.

(*a*)—Emmaville Division.

Lodes.

Bath's Lode.—Portion 116, Parish Scone, County Gough.

"In portion 116, Scone, is Bath's lode, the largest of the stockwork veins yet found near Emmaville. The vein strikes 5° north of east and

south of west, dipping southerly at 85°. The vein consists of a seam of quartz and tin-stone on either side of a central crack, both faces of which show slickensides, and it merges gradually into a quartzose quartz-porphyry, which passes into a similar rock, rather softer and less quartzose. Floors of quartzose quartz-porphyry extend laterally for a few feet on either side of the vein, probably formed by the infiltration of quartz derived from the vein along horizontal joints in the quartz-porphyry. It seems to me improbable that any of these minute veins, if sunk upon, would be found to widen out into payable lodes, except, perhaps, at great depths; for, considering that they have been worn down already for a vertical extent of at least 200 feet for a length of 3 miles, it might have been expected that had wide branches or shoots of tin-bearing quartz occurred in them, water-worn blocks of quartz vein-stone a foot or so in diameter would certainly have been found in the Cainozoic tin-gravels, as at many places on the Mole Tableland and in the Tingha district. Near Emmaville, however, the quartz pebbles in the leads seldom exceed 3 inches in diameter, the associated fragments of quartz porphyry measuring over 1 foot. There can be no doubt that all these minute veins are connected with the set about to be described, of which the Ottery is the principal one, and the rock in which they occur appears to be intimately related to the great dyke of hornblendic granite in Boiling-down Creek, to which the Ottery lode chiefly owes its origin."*

Blair's Lode.—Portions 31 and 50, Parish Land's End, County Gough.

"Blair's Reef, a vertical vein from 2 inches to 2 feet thick, strikes 42° east of north and west of south, the strike changing towards the south-west in a distance of 24 yards to 35° east of north and west of south. At the latter point the vein dwindles to a mere crack.

"The veinstuff is quartz and pearly chlorite, containing black crystals of tin-stone sprinkled through its mass like currants in a pudding. Bunches of ore extended from the surface downwards for 20 feet, when the vein became impoverished. The vein can be traced along the surface for 200 yards. The veinstuff, as before, lines the sides of a crack in the granite, and passes gradually into that rock. 15 yards south of the preceding vein is another, striking 38° east of north, and the whole of the granite south of this point to its junction with the claystone is traversed by a network of thin tin-veins."†

Blue Lode.—See "Paradise Lode."

Blue Lode.—Between Rumsay's Wolfram Lode and the south-west end of Yankee Tin Lode, Parish Land's End, County Gough. Strike north 75° west.

Opened to about 60 feet by several shafts connected by drives. Lode channel reported 2 feet wide at bottom; best ore about 8 inches thick. Worked intermittently for some years; last time about 1902-3. About 6 tons of tin-stone extracted.

Brendon's Lode.—Between Blair's and Graney's Lodes, Parish Land's End, County Gough. Discovered by Wilcox in 1905. Width 3 inches, in hard granite. Opened to 70 feet. Output, about 5 tons of tin ore.

Butler's Lode.—Portions M.C.P.'s 173, 174, 307 (now M.C.P. 8 and M.L. 175), Parish Highland Home, County Gough. Discovered by Butler and party in 1881 at the head of Alick Staine's Gully. The lode was traced on the surface for a considerable distance, and opened to a depth of 8 feet, where it was about 1 foot wide, some rich ore being obtained.‡

* Geol. Veg. Ck., 1887, p. 137. † David, *op. cit.*, p. 115. ‡ Ann. Rept. Dept. Mines for 1881, p. 102.

In 1883 it was announced that—

> "Butler and Company's reef of 60 acres had changed hands for the sum of £1,200 and 350 paid-up shares to each of the original holders. The lode in the main shaft was reported to bear east and west, and dip north 21 inches in 6 feet, and to be 3½ feet wide.*

C. S. Wilkinson, examined and reported in 1883 :—

> "Butler's, or the Dan O'Connell Lode, is from 10 to 30 feet wide, striking east 30° north, and traversing euritic and porphyritic granite. It consists of ferruginous chlorite rock, quartz veins, felspar, and eurite. The tin ore is regularly disseminated through the lode, and occurs chiefly in quartz veins and chlorite, while quartz veins of more recent formation cut through all these. Some of the quartz crystals are coated in a remarkable manner with stellated scaly masses of chlorite. There is also a little wolfram. The lode has been traced for about 20 chains, and for half that distance along its outcrop tin ore may be seen at intervals in it. Stone taken from the whole width of the lode would not pay for crushing, for the ore is so scattered that suitable crushing stuff would have to be culled from the mass."†

In 1884 W. E. Henry, Mining Registrar, reported that No. 1 Shaft at the north-east boundary has been sunk 42 feet, from which a level had been driven 42 feet, the lode being 4 feet wide.

No. 2 Shaft, about the centre of the section, was down 88 feet, with a level 30 feet in length; at this point, the lode was 23 feet wide, and of good quality, the best stone, however, occurring on the walls.

No. 3 shaft was down 80 feet, the lode averaging about 4 feet wide all the way. An intermediate shaft was down 40 feet, the lode being wide. Galena was reported in patches. A tunnel was driven 220 feet on the lode from the western end, where it was contemplated erecting a battery. Over 320 tons of lodestuff were at grass.‡

In 1885, a 10-head stamper battery, with 12 h.p. engine, was erected, a large quantity of stone being treated for 30 tons of tin concentrates.§

In 1886, W. H. J. Slee, Inspector of Mines, stated that a fair amount of work was done, but the mine was suffering from lack of capital for development.‖

In 1886, S. H. Cox selected the Butler lode for description as a type of true fissure lodes ¶ :—

> "The lode is a true one, lying between well-defined walls, and has an average north-east course, but where it pinches it generally takes on northing. In places the lode splits, and while one portion goes northward, the other hold its north-east course, the westerly branch as it leaves the lode underlying at a flatter angle than the more easterly one, so that the branches will probably junction again in depth."

(This proved correct in the latest developments carried out by Mr. H. Porter for the Austral Tin Company.—J.E.C.)

> "The richer portions of the lode are generally on the hanging and footwall sides of the reef, where the tin occurs associated with quartz alone, but in many places the whole width of the lode is sufficiently rich to pay for working."**

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* Ann. Rept., Dept. Mines, for 1883, p. 103. † *Op. cit.*, p. 149 ‡ *Op. cit.*, 1884, p. 99. § *Op. cit*, 1885, p. 93. ‖ *Op. cit*, 1886, p. 112. ¶ Journ. R. Soc. N. S. Wales, 1886, XX, pp. 93–109. ** *Op. cit.*, pp. 96–7.

In 1887, Mr. Slee reported that the Butler mine had been idle nearly all the year until it came into the possession of its new owner, who was prosecuting the work as well as he was able.*

In this year David published the results of observations made in 1883–4 :—

"Butler's vein has been traced for a distance of one mile through portions 173, 174, and 307, parish of Highland Home. The Alexsteane Gully, on the east side of which the vein is situated, is hemmed in by somewhat precipitous sides of rugged granite. The vein has, however, now been made accessible by road from Emmaville. The vein at the point where it leaves the bottom of the gully strikes up the sides of a steep hill in a direction varying from 26° to 32° north of east and south of west. At 10 chains in a north-easterly direction from its point of commencement the vein is split into two branches. At two chains further the east branch becomes split again, the right offshoot extending at least 16 chains before it dies out. The left, after becoming divided into three, rejoins the west branch at three points within a distance of 10 chains from the second split. A large 'horse' of granite is thus enclosed between these branches, 20 chains long and 4 chains wide. At 2 chains north-easterly from the north-east end of the 'horse' the main vein is lost for 1 chain; then, reappearing, can be traced for 12 chains, striking 32° north of east and south of west. At the end of this distance the vein becomes split again, the east branch dying out in 7 chains, while the west continues with some variation of strike for a further distance of 28 chains. The average strike of the vein is 35° north of east and south of west. The dip is north-west, varying from 72° to 85°. The thickness varies from 2½ feet to 10 feet, averaging 3 ft. 2 in. The vein was being systematically opened up from its south-west end for a distance of 10 chains by Butler's Tin-mining Company. An adit was being carried from this point, about 30 feet above the level of the creek along the course of the vein, and three shafts and one winze were being sunk to meet the adit, while the vein was being further tested by three surface cuttings. At 22 yards from the mouth of the adit the vein is 4 feet wide. The casing is eurite, passing into coarsely crystalline porphyritic granite. A vein of quartz joins the main vein at this point, striking 10° east of north and west of south. At the end of the tunnel, 150 feet long, the vein is 2½ feet wide, the centre consisting of quartz 1 foot wide, passing at the sides into chloritic quartz, which graduates into granite on the hanging-wall. The footwall is fairly well defined, and shows slickensides. At 44 feet below the level of the adit, and 77 feet from its commencement, a considerable quantity of water was met coming from the vein, which here dips 85° north-west, the country being fairly soft. In the open cutting, at which the winze (46 feet deep) was being sunk, a shoot of ore was cut pitching to the north-east. The lode-stuff in the face of the cutting was 10 feet wide. The tin-stone occurs in seams and bunches, freely crystallised in chloritic quartz.

"At No. 2 shaft, 68 feet deep, the vein, at least 6 feet wide, is fairly rich in tin-stone, dipping 85° north-west, and showing a good hanging-wall, but no footwall.

"In No. 1 shaft, 42 feet deep, the vein, 3½ feet wide, has a fairly well-defined footwall, but no hanging-wall, and dips 67° north-west. The vein-stone is a rather porous quartz, passing at the sides of the vein

* Ann. Rept. Dept. Mines, 1887, p. 113.

into a quartzose granite. The tin-stone occurred principally in the form of a shoot, 1 foot to 1½ feet wide, and about 6 feet long, pitching at the rate of 1 in 4. A little galena and blende are associated with the tin ore.

"In portion 174, in the same parish, at 5 chains easterly from the first split in the vein, a trench on the left branch proves it to be 4½ feet wide, and shows that the veinstone is composed of quartz and chlorite, with a seam of nearly solid tin-stone, ½ inch wide, next the south-east wall.

"At Ottery's workings, on the left branch, the vein, 3 feet wide, contains three seams of tinstone, having an aggregate thickness of 1½ inches. A cross course, filled with clay flucan, has moved the vein here a few feet to the north-east.

"At Ottery's 24-feet shaft, 123 yards further along the vein, the vein is 3½ feet wide, and tin-bearing for a width of 1 foot 8 inches, the tin being freely crystallized in drusy cavities in the veinstone, or in solid seams, chiefly following the smaller quartz veins traversing the mass of the lodestuff. The vein here dips 72° north-west, and has a well-defined footwall showing slickensides. Horizontal joints, or 'floors,' composed of gossany chlorite and clay, and not tin-bearing, cross the vein at intervals of about 2 feet, the vein being impoverished where they are most frequent. The surrounding granite consists of coarsely crystalline quartz, felspar, and dark mica, occurring in patches in more finely crystalline masses of a similar rock. The whole is traversed by veins of eurite bearing east and west."*

"Bell's vein is a continuation of the same vein beyond Ottery's. The vein is here from 2½ to 3 feet wide, containing more blende than tin-stone, and bears 32° north of east and south of west, dipping north-westerly. The absence of conformity between the strike of this vein and that of the joints in the surrounding granite, the occurrence in the vein of branches and 'horses,' as well as the evidence of the fissure having been reopened in places, prove this vein to be a true fissure vein.

During 1888 work was carried on continuously, the Inspector of Mines reporting that excellent stone was being raised.

In 1890 the Warden reported that for some time operations had been at a standstill in consequence principally of some dispute as to title between conflicting claimants.†

In 1891 nine men were employed ; the battery was idle owing to prospecting work only being in progress. The deepest shaft was 150 feet, and the tunnel about 300 feet long. 100 tons of lodestuff raised.‡

In 1892, Mr. S. L. Bensusan, of the Butler tin mine, is reported to have crushed 400 tons of lodestuff for 15 tons of tin ore, equal to 3·7 per cent.§

1893 and 1894 furnished no official records.

In 1895 it is recorded that little work was done on account of the low price of the ore.

After being allowed to lie idle for a number of years the mine was reopened in 1907, under option by the Austral Tin Company (London) ; it is recorded that :—

"The adit level on the line of lode was extended a further 336 feet, making the total length of the tunnel 788 feet.

* Geol. Veg. Ck., 1887, pp. 123–126. † Ann. Rept. Dept. Mines N. S. Wales for 1890, p. 103. ‡ Ann. Rept. Dept. Mines N. S. Wales for 1891, p. 125. § *Op. cit.*, 1892, p. 43.

Plan and Section of Butler's Lode

Parish of Highland Home County of Gough

Scale 0 50 100 Feet

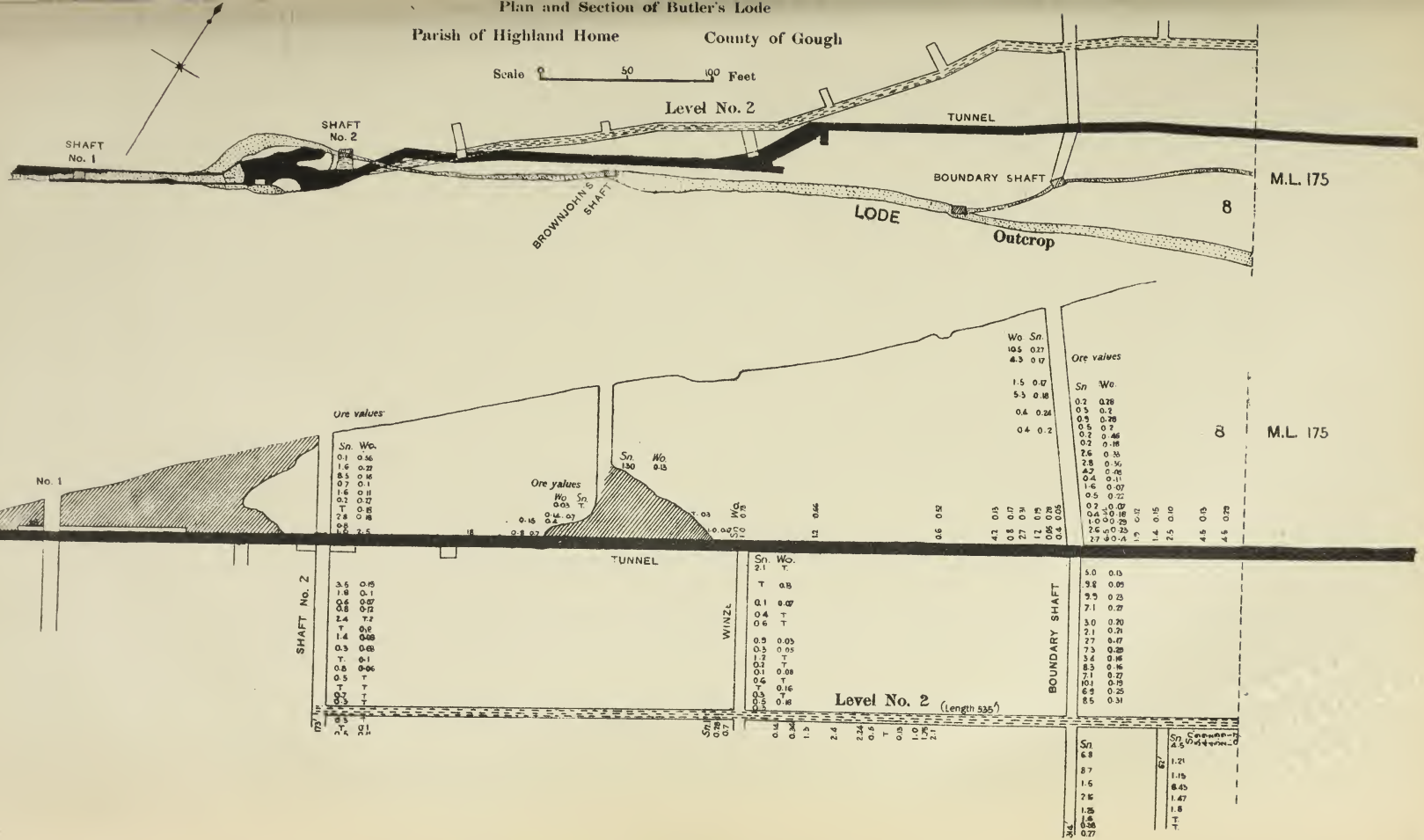

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PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

"Winzes were put down to test the value of the lode, and a depth of 80 feet had been obtained in one shaft. The lode is said to average 2 feet in width, and 1,000 tons of valuable ore were at grass at the close of the year. The development to date has been very reassuring, and promises to result in highly remunerative returns being obtained when the mine has been properly opened up."*

During 1908, exploratory work to the extent of 270 feet of sinking, and 320 feet of driving on the lode, was carried out. The lode was found to vary from 3 feet to 6 feet in width.†

During 1909 work was again at a standstill, owing to a reported dispute between the owner and the Company holding the option. At that time there were about 1,500 tons of lodestuff at grass, estimated to yield 2½ per cent., whilst the ore in sight, opened up ready for stoping, was estimated at 30,000 tons.‡

Inspected by the Writer, 19th October, 1908, and 10th June, 1910. On the first occasion when development was in progress; on the second when the mine had been unwatered to allow of sampling by Mr. W. A. T. Davies, on behalf of Bewick, Moring & Co., London.

From an examination of the latest developments—which are illustrated in the accompanying section—it is proved that the Butler lode is strong and well-defined between true walls. In places it widens to over 20 feet, in others pinches to about a foot. Large vugs occur, lined with very large quartz crystals exhibiting secondary growth.

The apex of the rich shoot discovered in 1907 by the Austral Company was struck in the north-easterly extension of No. 1 level, and followed down to No. 2 level, when it was driven on for about 120 feet. From the latter it was followed down in a winze for 40 feet, when it dipped easterly; the rich shoot thus being exposed for a depth of 140 feet by a length of 120 feet, and still showing in the back of No. 1 level. The channel varies from 1 to 22 feet, but the best values are confined to about 4 ft. 6 in. on footwall side, the latter narrowing proportionately with the channel. Beyond the rich shoot the stanniferous lodestuff has been proved for a total horizontal distance of about 380 feet. The lowest level is 314 feet from surface. The total length of adit, 822 feet. The greatest depth, 364 feet. Several cross-cuts driven to test width and values at bulges.

The vugs in the lode channel afford evidence of intermittent movement and progressive filling, large slabs or "horses" of country falling vertically in the cavities; between these, deposition of silica has not advanced to complete filling, hence cavities more or less completely lined with crystals. In other parts the whole of the cavities have been filled, and small "horses" and faultings are rendered apparent by the silicious cement.

Chlorite is a very prominent constituent of the lodestuff, the most interesting features being its investment of the quartz crystals, and enclosure of rich isolated kernels of cassiterite; the progressive order of deposition being quartz, tin-stone (and wolfram), and chlorite, in the order named.

De Milhou's Lode.—Subsequently known as the Emerald Mine. David, in his report on the discovery of emeralds in the Vegetable Creek district,§ states that they were discovered in an old shaft sunk many years previously for tin, known as De Milhou's Reef.

* Ann. Rept. Dept. Mines for 1907, p. 58. † *Op. cit.*, 1908, p. 52. ‡ *Op. cit.*, 1909 p. 52.
§ *Op. cit.*, 1891, pp. 229-234.

The only previous reference to the latter occurred in 1881, when it was noted that the lode was not being worked.*

David states that—

> "At the Proprietary Mine, and elsewhere in this locality, the emeralds occur in bunches or shoots, which dip obliquely along the plane of a quartz and topaz rock, carrying mispickel, tin-stone, and fluorspar."†

In the tips of the shafts sunk for emeralds, tin crystals are occasionally seen in the stone raised, but are of no commercial importance.

Cadell's Lodes (*also Cadell and Hall's*), Portion 10, Parish of Flagstone, County Gough.

In 1877 it was recorded that Messrs. Cadell, Hall, and party had taken up 100 acres at the head of Flagstone Creek, covering a tin lode, striking north-east in granite. Some rich specimens obtained.‡

In 1887 David published a description of these lodes as they appeared in 1883–4.

> "*Cadell's veins*, in portion 10, parish Flagstone, comprise two veins of quartz and tin-stone, striking 35° east of north and west of south, averaging ¾ inch in width. These veins swell out in places into lumps of solid tin-stone 16 inches wide; the granite is hard, euritic, and fine-grained. These veins appear to be joints in the granite, the ore being chiefly concentrated towards the middle of the joint, as well as freely crystallized into its sides.
>
> "*Cadell and Hall's vein* in portion 6, in the same parish, strikes about 10° north of east and south of west; the vein is composed principally of eurite traversed by 'blows,' and veins of quartz, with a little tourmaline and chlorite. In the latter the ore occurs massive in veins and vugs, while in the former it presents the appearance of small crystals peppered through the eurite. The ore occurred principally in a shoot extending vertically for 12 feet, when it became nipped. The surrounding granite is porphyritic by quartz and orthoclase felspar."§

Carr's Lodes. (See *Red Cross Lodes.*)

Clifford's Lodes. (See *Yankee Lode.*)

Curnow's lode, Portion 492, Parish Highland Home, County Gough.

In 1881 it is recorded that the Great Britain Tin-mining Company's operations at "Curnow's lode" had disclosed a fine lode running in an easterly and westerly direction. A shaft had been sunk 104 feet, the lode continuing all the way down; it was also traceable over the crown of the hill upon which the shaft is situated. At the 104-feet level the lode was 4 feet wide, 18 inches of which was regarded as 6 per cent. stone.‖

In 1882, shafts were being sunk by contract. No. 1–45 feet deep, had to be abandoned on account of water. No. 2—down 170 feet—with tin visible all the way; the lode being 18 inches wide. A level driven 25 feet revealed 3 feet of tin-bearing stone with only one wall. No. 3, or main shaft, 8 ft. 6 in. x 4 ft. 6 in., was down 38 feet. Another shaft was down 30 feet on the side of the hill.¶

In 1883 it was examined by C. S. Wilkinson, who reported:—

> "Curnow's lode crosses the summit of a high ridge on the west side of Lottery Creek. On the surface it is about 3 feet 8 inches wide, narrowing lower down (so the manager, Mr. Knuckey, informed me) to 1 foot when it widens again to 4 feet or more. It strikes east 42° north, and

* Ann. Rept. Dept. Mines N. S. Wales for 1881, p. 102. † *Op. cit.*, 1891, p. 230. ‡ *Op. cit.*, 1877, p. 150.
§ Geol. Veg. Ck., 1887, pp. 118-9. ‖ Ann. Rept. Dept. Mines for 1881, p. 102. ¶ *Op. cit.*, 1882, p. 90.

underlays to the south-east. It consists of chlorite and quartz with tin disseminated through it. A shaft has been sunk upon it to a depth of 160 feet. Parallel with it, about 40 feet from it on the south-east side, are four other similar lodes within a belt of 14 feet; these probably run into one another. On the north-west side three other lodes are seen outcropping at the surface; and between Curnow's and the Dutchman's, another lode has been opened, consisting of ferruginous crystalline quartz with chlorite and clay; it is from 2 to 3 feet wide and strikes north 32° east. A crushing plant on Lottery Creek was to be erected at the time of my visit, for treatment of the ore from these lodes.*

David in 1887, recorded the condition of the lode in 1883-4 :—

"In the parish of Highland Home, county Gough, Curnow's vein strikes 40° north of east and south of west, dipping 95° north-westerly. The vein is from 2 to 6 feet wide, averaging 3 feet, and has been traced along the surface for 18 chains. The veinstone is quartz and chlorite, with tinstone well intermixed. A shaft has been sunk on the vein to a depth of 200 feet. At 104 feet from the surface an easterly drive along the vein proved that the vein became contracted to a thickness of 2 feet, at which point it ceased to be tin-bearing; and the same was experienced in a westerly drive 28 feet long at the same level. At 130 feet from the surface the vein was tunnelled 35 feet west and 40 feet east, and was 6 feet wide at the shaft and 3 feet at the ends of the drives, and still tin-bearing. The contiguous granite is fairly soft, and contains geodes of felspar."†

The later operations were not separated from those of the Dutchman, with which it was incorporated.

The Austral Tin-mining Company also held this lode in 1907—the main shaft was said to be 280 feet, a little tin occurring at that depth.

Dutchman Tin Lodes, M.C.Ps. 1, 10, 165, 166, 167, Parish Highland Home County Gough.

The first of these lodes was discovered between 1874 and 1875, the first reference to it being in 1875 :—

"At another lode known as the Dutchman's Reef, 1½ miles from Byrne's (Reef.—J.E.C.), very good tin-bearing stone has been found. Only shallow cuts have been put on it, which disclose but imperfect indications of veins of ore."‡

In 1877, the same authority states that only "two blocks of 20 acres each have as yet been taken up. The indications here are very good, only one trial shaft having been sunk. A few surface holes have also been put down, disclosing the run of the lode, which is north-east and south-west, and to prove the existence of tin ore. The shaft is only down a few feet, yet it shows the cap of the lode to be fully 6 feet wide, but apparently at the bottom of the shaft the lode is divided into two legs. The quartz is richly charged with tin ore and has well-defined walls of soft granite, so although it is impossible to say from what little work has been done if it will prove a permanent lode, still the prospects are very encouraging and should induce owners to invest capital on their land to more thoroughly try the lode."§

* Ann. Rept. Dept. Mines for 1883, page 149. † Geol. Veg. Ck., 1887, pp. 127-8. ‡ G. H Gow Ann. Rept. Dept. Mines for 1875, p. 107 § *Op. cit.*, 1877, p. 149.

Want of capital retarded development during 1878 and 1879. In 1880 the Great Britain Tin-mining Company acquired about 800 acres of lode-tin land by purchase and lease at Mole Tableland, including the Dutchman Lode, on which they began exploratory work.*

In 1881, it is recorded that the company had sunk a shaft 80 feet deep in this lode; the lode at the bottom, about 1 foot wide, disclosing encouraging prospects of tin.†

In 1882, this shaft was full of water, the company beginning another shaft at the boundary of blocks 62 and 63.

In 1883, C. S. Wilkinson examined the lode and reported :—

> "The Dutchman's lode, in the parish of Highland Home, has been traced for nearly half a mile, strikes east 30° north to north-east. It is 3 to 4 feet wide, and consists of quartz with chlorite and tin ore. It has some remarkable cavities, the sides of which are lined with clear crystals of quartz from 3 to 5 inches long; crystals of tin ore occur at the base of the quartz crystals. It is evident that both the oxide of tin and the silica have crystallized from the same aqueous solution which once filled these cavities. One of the cavities measured 2 feet in diameter. The reef has been opened by two tunnels put in from its outcrop on the western side of the hill, and higher up on the hill by a shaft 104 feet deep. The reef at the tunnel entrance is split in two by a horse of granite 3 feet wide. A large quantity of tin-bearing quartz can be readily obtained, but it will require culling before sending to the machine as the ore is irregularly scattered through it. On the north-west side of this reef and 60 feet from it is another reef parallel with it, and 3 feet thick, containing tin ore."‡

During this year the property changed hands. The new company installed a 12 h.p. engine, 5-head stamper battery, and concentrating plant consisting of six jigs, four buddles, and one dead buddle. No. 1 shaft was deepened to 200 feet, in which the lode averaged 3 feet. No. 2 shaft, 40 feet deep, disclosed 1 foot 6 inches of lode stuff throughout. From this shaft the lode was driven on 75 feet each way from the bottom.§

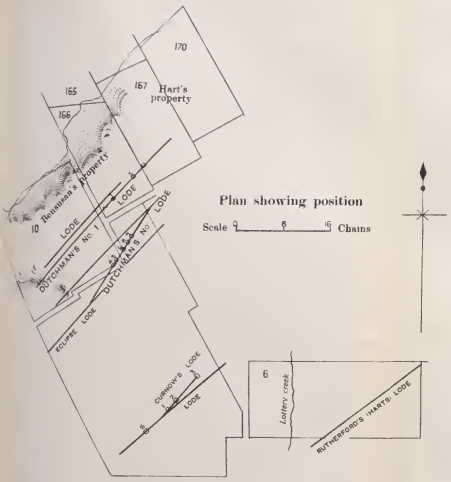
During 1883–4 David was engaged on his geological survey of the district, and subsequently published the following description of the Dutchman lodes :—

> "The vein known as 'No. 1 Dutchman' strikes through portions 165, 166, and 167, parish of Highland Home, in a direction 34° 30′ north of east and south of west for 10 chains, then 38° 30′ for 12 chains, the vein having been traced on the surface for a total distance of 22 chains.
>
> "The dip is 81° north-westerly, but the vein is vertical in places. The width varies from 3 to 6 feet, averaging 4 feet. The foot and hanging walls are well defined, and show slickensides, and the granite casing is soft. The veinstone is principally quartz, with some chlorite. Two levels have been driven along the vein from its south-east end, the upper 70 feet long, and the lower 240 feet. The end of the lower tunnel is 70 feet below the surface, there being 44 feet of unworked vein between the two levels. At the mouth of the lower level the vein was split by a 'horse' of granite, which increased in width to the north-east. At the end of the upper tunnel the ore was chiefly distributed through

* Ann. Rept. Dept. Mines for 1880, p. 164. 1883, p. 149. † *Op. cit.*, 1881, p. 102. ‡ Ann. Rept. Dept. Mines for
§ *Op. cit.*, 1883, p. 104.

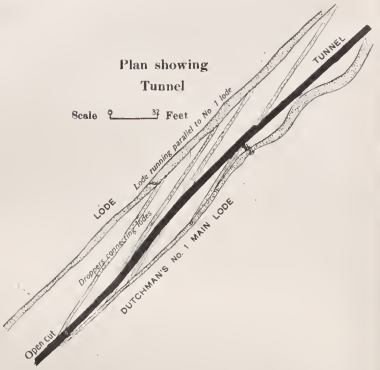
PLAN AND SECTIONS OF THE DUTCHMAN'S, &c. LODES. *(From Mine Managers plans)*

Parish of Highland Home — County of Gough



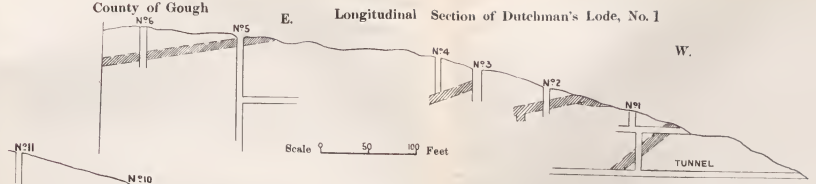
Plan showing position

Scale 0 8 16 Chains



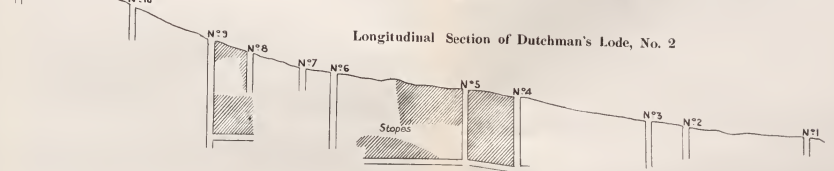
Plan showing Tunnel

Scale 0 32 Feet



Scale 0 50 100 Feet

Longitudinal Section of Dutchman's Lode, No. 1

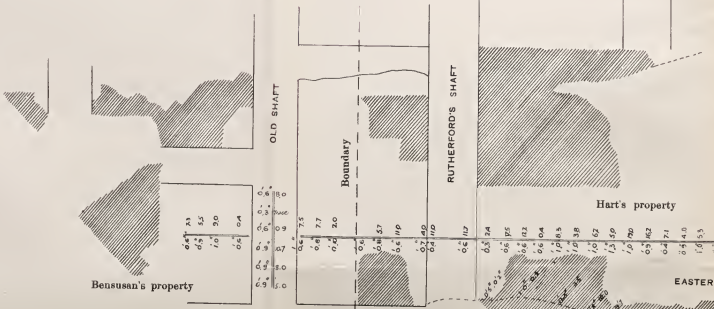


Longitudinal Section of Dutchman's Lode, No. 2

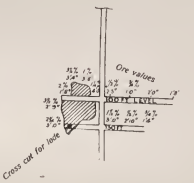
SECTION

Shewing ore values. &c.

Scale 0 8 16 Feet

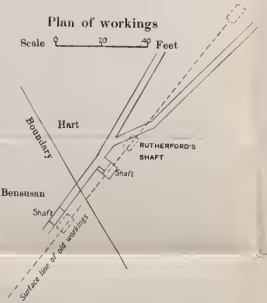


Longitudinal Section of Curnow's Lode



Plan of workings

Scale 0 20 40 Feet



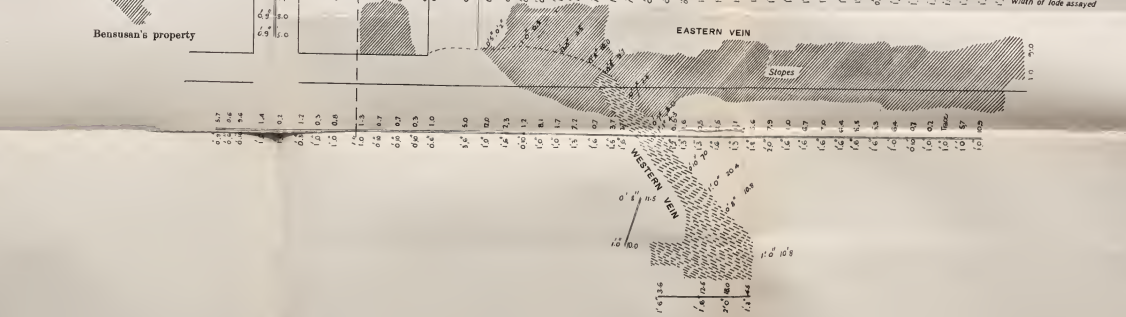


PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

a vein 1½ feet wide on the south-east side of the 'horse,' and went to the footwall, which was well defined. Several cavities were met with in the vein, 1 foot in diameter, lined with beautifully-formed crystals of clear and smoky quartz, 8 inches long, enclosing crystals of tin-stone. 1,500 tons of stone were at grass ready for crushing at the time of my visit.

"No. 2 Dutchman strikes through portions 4A, 3A, and 2A in the same parish, in a direction 28° east of north and west of south. The vein is 3 feet wide, and tin-bearing for 1½ feet. In portion 2A the vein becomes split into two branches, the south branch striking 38° north of east and south of west, and the north 35° east of north and west of south. Over 180 tons of veinstone have been raised from this reef. 130 tons crushed yielded over 10 tons of tin ore. The average yield of the total amount of ore crushed at these mines at the time of my visit was 3¾ per cent. of tin-stone."*

The Dutchman crushing plant consisted of 5-head stamper battery, with fittings for 15 head 12-h.p. portable engine, 5 sets of jigs, 2 convex buddles, 1 Blake's steam pump.†

During 1884, 500 tons of lode stuff were treated. No. 1 shaft was driven at the 130 feet level 42 feet each way along the lode.

The back of the south-western drive was stoped 4 feet high and 12 feet long, the lode here being 3 feet wide. Stoping, 12 feet by 6 feet, was also done in this direction at the 104 feet level.

No. 2 shaft, to the eastward of No. 1, was deepened to 82 feet, and drives put in south-westerly.

No. 3 shaft was down 56 feet on the parallel lode. The tunnel was extended to 229½ feet, the lode showing 2½ feet wide.‡

During 1885 the mine was worked on tribute, the Company providing engine and treatment plant; the yield from the lode being 66 tons 2 cwt. 3 qr. 11 lb. tin ore.§

In 1886 Mr. A. McGillivray assumed the management, twenty men on an average being employed, the yield of tin ore being 49 tons, the deepest level about 215 feet, and the average width of lode 2 feet 6 inches.‖

In 1887 apparently prospecting only was done. In 1888 preparations were being made for reopening. Mine apparently remained closed down from 1888 to the end of 1906, when it was being unwatered with a view to resumption of mining, an option having been secured by the Austral Tin Company of London.

During the first half of 1907 the mine received a good trial, operations being suspended in June. The work carried out included cleaning out the old shaft to the 246 feet level; and deepening No. 4 shaft on No. 2 lode to 211 feet. The lode in the latter was practically barren between the early workings down to 80 feet, and the last few feet of sinking, when ore was again beginning to show in the lode.

Mr. H. Porter, who superintended the Austral Company's operations at the Butler and other lodes in the vicinity, kindly supplied the following particulars concerning the Dutchman lodes :—

No. 1 lode has been opened along the outcrop for a distance of 772 feet by shafts and trenches. A few feet from the north boundary a trial shaft

* Geol. Veg. Ck., 1887, p. 128. † *Op. cit.*, p. 152 ‡ Ann. Rept. Dept. Mines for 1884, pp. 98–9.
§ *Op. cit.*, 1885, p. 93. ‖ *Op. cit.*, 1886, p. 89.

was sunk 50 feet, and a considerable amount of stoping done of fair average stone. The lode persists at the bottom, but is not payable. 144 feet from this boundary line No. 5 shaft was sunk 112 feet. In sinking some fair stone was raised from the first 60 feet; below this level it depreciated. At the bottom of the shaft the lode is 2 to 3 feet wide, and of a promising nature. Further south a series of shafts and open trenches have been made in the back of the lode where fairly large deposits of ore were worked, mostly on tribute. At the foot of the hill a tunnel has been driven 300 feet, which, if continued, would pass under No. 5 shaft 24 feet below bottom, and 136 below the summit of the hill.

No. 2 lode, about 300 feet east of No. 1, 11 shafts and prospecting holes sunk along this lode to varying depths, a considerable amount of stone being stoped and treated at the local battery. At the top of the hill Nos. 10 and 11 shafts where sunk 30 and 50 feet, and average grade stone extracted. At the bottom, however, it was much poorer. No. 9 shaft, to the south of the former, was sunk 130 feet, and driven southerly at this level for 43 feet, the ore in the back of the drive being stoped out. Ore still under foot dipping south. Width about 2 feet. The matrix is quartz, and the ore very easily concentrated. This shaft was continued to 240 feet, the lode being fairly well defined.

Still further south No. 4 shaft was sunk over 100 feet, the lode in the bottom being 1 ft. 6 in. to 3 feet wide, dipping slightly southward. From the surface at this shaft good ore was obtained.

Further south are three other shafts from 10 to 30 feet deep, all of which have yielded ore of more or less value. The total horizontal length represented by these shafts being 850 feet.

Emerald Lode.—See De Milhou's lode.

Fergusson's Lode.—Portion 161, Parish Highland Home, County Gough. Described by David:—

> "The *Fergusson vein*, 2 feet wide, in portion 161, in the same parish, strikes 40° north of east and south of west, dipping north-west, and is probably a continuation of the Walleroo vein. The foot wall is well defined. The vein stuff is chlorite and quartz, the former occurring massive, or in veins or concretions in the quartz. The tin-stone is disseminated through the quartz and chlorite, associated with iron pyrites and wolfram. The country is a coarse hard granite merging into the veinstone.*

Flagstone Lodes.—See Cadeli's, Halls, Paradise, Heisers, &c. In 1890 the Warden reported that in the parishes of Muir, Land's End, and Flagstone, numerous veins and lodes, more or less rich, occurred. From returns to hand it appeared that twenty-six European miners obtained 21¼ tons of dressed ore from a number of these lodes during 1890, all hand-dollied and dressed.†

Frendon's Lode.—Parallel to and 80 yards from Graney's pipe lode, Parish Land's End, County Gough. Opened to about 90 feet in depth, width 10 to 12 inches. Output about 8 tons tin ore.

Gaden's Lode.—Portion 33, Parish Muir, County Gough. In 1877 it is recorded that Messrs. Gaden and party applied for a large area at The Gulf, and were sanguine of striking a good lode, as all the tin obtained in alluvial workings was heavy lode tin, little water-worn, and some attached to quartz. Shaft down 27 feet.‡ Examined by David in 1883–4.

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* Geol. Veg. Ck., 1887, p. 133. † Ann Rept. Dept. Mines for 1890, p. 103. ‡ *Op. cit.*, 1877, p. 150.

"*Gaden's Lode*, the furthest west of the abovementioned lodes, is situated in Portion 33, Parish Muir, County Gough. The vein is from 2 to 3 feet wide, and strikes 40° east of north and west of south, dipping about 82° south-easterly. Veinstone chlorite and quartz, with vugs filled with purple fluorspar. The walls are not defined, the veinstone merging into a very quartzose ternary granite, becoming less quartzose at a distance from the vein. Shaft sunk on vein 24 feet deep."*

Gap Lode.—Between Portions 163 and 165, Parish Land's End, County Gough. *Gap vein* strikes 13° north of east and south of west, dipping northerly at 80°. The vein is from 2 inches to 1 foot in width, composed of tin-bearing quartz enclosed in soft ternary granite, porphyritic by orthoclase. The walls show distinct slickensides. Yield, 2 tons of ore.†

Glen Creek Lode.—McKinnon and party, during 1908, obtained 12 tons of tinstone from a rich vein 4 inches in width.‡

Graney's Lode.—Portion 53, Parish Land's End, County Gough. In 1882 it is recorded that in Graney and Company's ground a shaft had been sunk 15 feet, exposing a rich vein, about 15 inches thick, in hard rock. Another shaft, 33 feet deep, 200 yards from the first, exposed the vein 2 ft. 6 in. thick, with tin all through.§

During 1883 work was suspended pending other arrangements.‖

Fig. 6. Graney's Pipe, Emmaville.
(After David).

*Geol. Veg. Ck., 1887, p. 111. † *Op. cit.*, p. 118. ‡ Ann. Rept. Dept. Mines, 1908, p. 52. § *Op. cit.*, 1882, p. 91. ‖ *Op. cit.*, 1883, p. 102.

In the same year it was examined by C. S. Wilkinson, who recorded that :—

> "Graney's lode in Portion 53, Parish of Land's End, is a very remarkable pipe-vein in hard granite. At the surface the vein, or shoot, consisted of an oval-shaped mass of ore with felspar 2 feet long and 18 inches wide ; at 20 feet it is said to have been 5 feet by 2 feet ; and at about 40 feet, the depth at which I saw it, it was 2 ft. 6 in. long by 6 inches wide. Some fine blocks of almost pure ore from this lode, sent by Mr. Graney, of Emmaville, to the Mining Museum. This pipe mass of ore went down with an irregular dip of about 66° towards north 20° east. It seemed to be quite isolated, but I believe that it will be found to connect with a small vein in which a small patch of tin-ore is seen at the surface at a distance of 83 feet, north 18° east from Graney's Shaft.*

David also examined this lode and described it as a "carbona or impregnation of the 'flattened sausage type." The shoot of ore was cylindrical or oval. The general dip is 20° south of east. The dip varied from the surface downwards, as follows :—

0–20 feet, 20° north of east and south of west, at 55°.
20–50 feet, 5° „ „ „ at 45°.
50–60 feet, vertical.

At 20 feet from the surface, where the shoot was largest, it measured 5 feet by 2 feet. At the bottom of the shaft the ore was seen to occur freely crystallized or massive, in a veinstone of white felspar, chlorite, and quartz, which followed a crack in the granite. No trace, however, of this crack could be seen at the surface, the granite being closely jointed in a direction 30° east of north and west of south, and being very hard.

The sinking cost £6 per foot ; the yield was 4 tons.†

The nature of the pipe is shown on figure 7. (See page 133).

Gulf Stream Tin Lodes.—Portion 23, Parish of Muir, County of Gough.—In 1875 it is recorded that at Gulf Creek, 18 miles north of Vegetable Creek, some very promising lodes had been discovered, from some of which a considerable amount of loose tinstone had been obtained.‡

In 1877 it was announced that "very great excitement was caused at another portion of this district by the discovery of an extremely rich lode or dyke of nearly pure tin ore in the Gulf Stream Company's lodes, portions 59 and 60, situated at the Gulf Creek, 24 miles north-west of Vegetable Creek, by a party of men who had been prospecting about that locality. The two or three men, after obtaining 27 tons of tin from this dyke in about four or five months by means of crushing the tin stuff, which was quite soft, with hand-dollies, were turned off the land by another party of six or eight men, who jumped it on the ground of prior right of application. This party raised about 60 or 70 tons of ore during the months of March, April, and May, when the original lessees, who were residents of Sydney, put in their claim to the land by virtue of leases for these blocks having been granted and executed by them in July, 1872.

"After a great deal of delay and a troublesome lawsuit, Messrs. Banks and party obtained possession of their land, on which they at once started to work in a proper and systematic manner. The open cutting from which the men had dug out 80 or 90 tons of tin was filled up, and a shaft started, when, at

* Ann. Rept. Dept. Mines for 1883, p. 150. † Geol. Veg. Ck., 1887, p. 116. ‡ Ann. Rept. Dept. Mines for 1875, p. 109.

a depth of 36 feet from the surface, the lode or dyke of tin pinched out like a wedge. From this level a drive was put in a distance of 127 feet along the course of the lode, which averaged a width of 3 feet, and was stoped out overhanded to within 5 or 6 feet of the surface, where it again ran out in the shape of a wedge, and from the whole of this space worked out 229 tons of tin were raised, besides a large heap of tin-stuff now on surface, which the manager reckons will produce more than 40 tons of ore when he has sufficient water for sluicing; so that from this mine every cubic yard worked out has yielded the enormous quantity of about 16¾ cwt. of clean tin ore."

"The run of this wonderful deposit of tin was about east and west, and enclosed in very soft granite. The strike of the rock on either side was north-east and south-west.

"Another shaft is now being sunk westerly of the old one, and at the end of the long drive, in which this lode of tin is again making, and is at present about 1 foot wide, and nearly as rich as ever.

"A Chilian mill has been erected close to the sluicing appliances. . . . This company has produced from this lode since it was restored to them in June last 132 tons of tin, and would have very considerably increased that yield if the supply of water had not been exhausted so soon."*

In 1878 the aspect of the Gulf lodes was described as the reverse of encouraging; beyond a little deeper sinking on the Gulf Company's property, little was done. In the case of this company, the lode appeared to have been worked out to the bottom of certain breaks at a depth of 25 to 30 feet, and never afterwards picked up below.†

In 1881, the Gulf Creek Company let a contract to sink their shaft 50 feet deeper, the present depth being 120 feet.‡

In 1882 the shaft was 150 feet; good tin ore reported at 130 feet. A drive was being put in at the 45 feet level.§

In 1883 operations ceased, and were not resumed in 1884. Work was again in progress in 1885 so far at least as milling was concerned.

The condition of the lode in 1883–4 is thus described by David :—

> "The Gulf Stream Company's lodes are situated in portion 23, parish of Muir, county Gough, and in portions 59 and 60, parish of Land's End, and have produced over 270 tons of tin ore."
>
> "In Portion 23, Parish of Muir, a vein of chlorite and quartz, part of the main vein, has been mined for a distance of 34 yards. A shaft sunk at the point shown on fig. 6 struck a shoot of ore at a depth of 40 feet from the surface. The shoot, which was from 4 to 5 feet in vertical measurement, and about 10 inches wide, dipped aslant the plane of the vein in an easterly direction, 20 feet vertically in a horizontal distance of 49 feet, producing 7 tons of ore. The main body of ore was worked in Portion 60, Parish Land's End, County Gough. The veinstone, in places 8 feet thick, averages 2 feet in width, consisting of chlorite, quartz, and decomposed white felspar; strike 1° south of east and north of west; dip, 72° northerly."
>
> "A remarkable shoot of ore has been worked here for a distance of 3½ chains. The shoot commences at 8 feet from the surface, and was found to dip east gradually for a distance of 10 yards, where it pitched down at a steep angle. At 12 yards from the point of commencement,

* Ann. Rept. Dept. Mines for 1877, pp. 149. 150. † *Op cit.*, 1878, p. 128. ‡ *Op. cit.*, for 1881, p. 102. § *Op. cit.*, for 1882, p. 91.

and 40 feet below the surface, the shoot was split by a horse of granite, part of the vein branching off in a direction west 35° north. Going east from this point a very rich course or shoot was struck, perhaps a continuation of the preceding. The top of this shoot was 15 feet below the surface, the shoot itself was 15 feet deep, 127 feet long, and from ½ to 8 feet wide, producing in that space 229 tons of tinstone, at the rate of 16¾ cwts. per cubic yard."

"Two more shoots were cut in this shaft, as shown in figure 6; the middle one, at 120 feet from the surface, measuring 18 inches by 10 inches; and the lower at 172 feet, being 3 feet deep, and from ½ to 2 feet wide. The tinstone in all these shoots occurs freely crystallized or massive in chlorite and quartz veinstone. Fluorspar and wolfram are associated in small quantities. Where the tin is freely crystallized, its distribution through the veinstone suggests that all the materials composing the latter were in solution simultaneously, their admixture is so thorough."

"Felspar crystals enclose minute crystals of tinstone, merging at their outlines into a finely crystalline mass of tinstone and felspar. At intervals of from 3 to 6 inches are tiny vugs, ¼ to 1 inch diameter, lined with beautifully formed crystals of tin-stone, black, resin, ruby, and translucent. An oval patch of beryl-rock, 12 feet long, 4 feet high, and 1 foot wide, was found at the spot shown on figure 6 at 30 feet from the surface, enclosed by nearly pure tinstone, the lode at this point being 9 feet wide."

"The beryls occur in hexagonal prisms, longitudinally striated, from $\frac{1}{16}$ to ⅛ inch in diameter, and from ¼ to 2 inches long. The prevailing colour is pale blue, passing into green. The crystals are fractured, showing that after consolidation the matrix in which they are embedded was subjected to disturbing influences. This matrix, which is of a dull red colour, consists of jasperoid quartz and mica, containing a little tin-stone. At the 75 feet shaft (see Fig. 6) the main vein branches, and further east each branch, is intersected by two parallel cross-veins. At the point where the eastern cross-vein intersects the main branch of the main vein, the rich shoot terminated abruptly against a wall of granite. The two parallel cross-veins strike north-east and south-west, the eastern composed of chlorite, quartz, and tinstone, averaging 1 foot in width. This vein ceased to be tin-bearing south-west of the point where it intersected the northern branch of the main vein.

"Fifty-nine yards north-east from the 175-feet shaft the eastern cross-vein intersects another tin vein, coursing first 10° south of east and north of west, then 22° south of east and north of west. The vein is from 4 to 5 inches wide, composed of tin-bearing eurite, dipping 72° northerly, and has been sunk upon to a depth of 30 feet. The abrupt ending of the main vein at its point of intersection with the east cross-vein suggests that a heave may have taken place. As most veins are faulted in direction contrary to their dip, the lost vein should be prospected for S.S.E. of the main shaft. The granite hill, near the top of which this vein has been worked, has a rapid slope to the south to the Gulf Creek, falling over 400 feet in a distance of half a mile. An adit might therefore be driven into the hill on the strike of the main vein to recover the lost shoots."*

* Geol. Veg. Ck., 1887, p. 112–113.

Hall's Grampian Lodes.—Portion 95, Parish Strathbogie North, County Gough.

In 1875 it was recorded by G. H. Gower that—

"Another part of this district where tin lodes have of late been discovered is the Grampians, the property of Messrs. Hall Bros. & Co., consisting of 1,000 acres under conditional purchase, and situated about 6 miles north-west of Vegetable Creek (Emmaville—J.E.C.). Most of the gullies rising from the high range in this property have been worked to considerable advantage for stream tin, and, as very large lumps of tin in quartz were sluiced out of them, the spirited managing partner, Mr. J. W. Hall, was induced to prospect for the lode, the source whence these blocks must have been detached. On the top of the range, which is about 600 feet (by aneroid) above the Vegetable Creek, the formation is felspathic and thickly impregnated with tin ore, and is also a complete network of veins, varying in width from $\frac{1}{16}$ to $2\frac{1}{2}$ inches of quartz and tin ore, and many are a compact mass of crystals of tin ore only. Associated with these faces of tin are topaz and mispickel; a lode of the latter is situated on the south side of the range, and contains tin-bearing stone 2 feet wide. On the same side of the ridge, being towards Vegetable Creek, are numerous low ridges, on which the outcrops of lodes have been found of late: large rock-veined stones were also found weighing from 1 lb. to 1 cwt., which would assay from 3 to 30 per cent. of ore. Some of these stones were of a very remarkable character, composed of mispickel, wolfram, and tin ore, and others are almost pure tin, with cavities. In several of these cavities are loose pieces of fluorspar. Again, there is another lode cropping out on the surface, some 5 feet wide, which is composed principally of fluorspar, a little quartz, schorl, and tin ore. A shaft has been sunk on the probable continuation of this lode some half-a-mile distant north-easterly. On the surface the lode was composed of mispickel, quartz, and a little tin; at a depth of about 20 feet some good stones of chalcopyrite were found, and the lode, 4 feet wide, contained tin ore, mispickel, chalcopyrite, erubescite, chessylite, and brown iron ore. At a depth of 30 feet the lode produced tin ore, copper ore, galena, and mispickel. At this depth the lode is well-defined, having a bearing about east 40° north."*

In 1883, C. S. Wilkinson, reported:—

"At Hall's claim, upon the Grampian Range, the talus on the south flank of the range is worked for stream tin. The tin ore is angular, and some pieces of it are found adhering to the slate, showing that it has been derived from veins traversing the slate. Near this a vein has been prospected to a depth of 50 feet in altered slates, and in the vein stuff occur mispickel, iron pyrites, copper pyrites, black oxide of copper, zinc-blende, fluorspar, galena, and white mica.

"An assay of a sample of this ore gave:—

Metallic zinc, 20 per cent.
Fine silver, 61 oz. 13 dwts per ton.
No gold or tin.

It has also yielded copper (about 5 per cent.), also a small quantity of lead.†

David published the result of observations in 1883–4:—

"At Hall's Grampians, in Portion 95, in the Parish of Strathbogie North, in the same county, several thin veins of tin-stone and quartz

* Ann. Rept. Dept. Mines for 1875, pp. 108–9. † Ann. Rept. Dept. Mines for 1883, p 151

strike 35° north of east and south of west. The veins are nearly vertical from $\frac{1}{4}$ to $\frac{3}{4}$ inch thick. The country is a thickly-cleaved highly-altered claystone, almost a felstone in places.

"In portion 101, in the same parish, a vein from 2 to 3 feet wide strikes 27° north of east and south of west, underlying north-westerly. The veinstone is a friable cellular quartz, containing arsenical pyrites, tin-stone, and wolfram. This part of the hill, for a length of $\frac{3}{4}$ of a mile and a width of $\frac{1}{2}$ a mile, is a perfect network of minute veins of quartz and tin ore, the veins following the cleavage of the claystone."*

Hall's Lode.—M.L., Parish Muir, County Gough.

In 1877, Hall and party took a lease of 20 acres on a lode about 3 miles south-west of the Gulf Stream lodes, striking north-east. Rich specimens were obtained from the outcrop.†

Haystack Lode.—About 4 miles west of Red Cross Lodes, discovered by R. Charlton about 1907. Opened to a depth of 90 ft., following a tin-pipe 4 ft. by 8 ft. in diameter. Output 16 tons 8 cwt.

Heiser's Lode.—Portion 69, Parish Flagstone, County Gough.

In 1877 it was recorded that on Heiser and party's 40 acre lease, on Flagstone Creek:—

"A lode has been discovered showing good tin all through the stone, at a depth of 20 feet from surface."‡

David examined this lode in 1883–4, and described the lodestuff as "a greisen composed of chlorite and quartz, in hard quartzose granite porphyritic by orthoclase, and containing schorl, strike 15° to 20° east of north," shaft 30 feet deep."§

Howe's Lodes.—Portion 266, Parish Highland Home, County Gough.

Described by David as continuations of the Dutchman lodes:—

"The northern vein strikes 40° north of east and south of west, and is from 2 to 3 feet wide. The southern varies in its strike from 40° to 45° east of north and west of south, dipping 64° south-easterly. This vein is from 3 inches to 15 inches wide, composed of quartz and chlorite, the footwall being well-defined, and showing slickensides. The country is fine-grained granite. The vein has been trenched to a depth of 10 feet, yielding $3\frac{1}{2}$ tons of tin ore."‖

Lewis and Griffith's Lode.—Near Tent Hill.

This lode was recorded in 1875 by G. H. Gower:—

"Another lode situated near that above mentioned (McMaster's Lode, Tent Hill.—J.E.C.) on which some little labour has been expended, is that of Lewis and Griffiths; at present no work is being done on this lode although the shaft is sunk to a depth of 42 feet, and the lode from the surface has gradually improved, being now well-defined, 18 inches wide and producing good tin-bearing stone throughout."¶

Macdonald's Lodes, Glen Creek.—Portions 2 and 5, Parish Paradise North, County Gough.

In 1875 it was announced that from the Glen Creek northerly to the Mole Tableland, several lodes had been discovered and opened to depths varying from 3 to 25 feet; the widths varying from 6 inches to 6 feet."**

In 1883 C. S. Wilkinson reported:—

"On the north side of Glen Creek are some remarkable veins known as McDonald's lodes, upon which a good deal of prospecting has been done, and some rich patches of ore are said to have been obtained

* Geol. Veg. Ck., 1887, p. 127.
† Ann. Rept. Dept. Mines, 1887, p. 150.
‡ *Op. cit.*, 1887, p. 15
§ Geol. Veg. Ck., p. 118.
‖ *Op. cit.*, p. 129.
¶ Ann. Rept. Dept. Mines, 1875, p. 10
** *Op. cit.*, p. 107.

Here a hornblendic felsite dyke, about 12 feet wide, strikes east 20° north, through fine-grained hornblendic granite with black mica. The dyke is traversed by numerous (in one place I counted fifteen) veins, from mere threads up to 3 inches thick, of black tourmaline, the larger of them with crystalline quartz in the centre ; the tin occurs irregularly both in the tourmaline veins and quartz. This is near the junction of the granite and altered sandstones and slates. Further back from the creek, near the head of a gully, some tin has been obtained where the surfacing rests upon coarsely crystalline rock composed almost entirely of hornblende."*

David, who examined the lodes shortly after the above, reported copper pyrites and fluorspar in addition to schorl as associates of the tinstone; and reported the discovery of scheelite in this locality.

The payability of the tin veins, in his opinion, depended on their becoming united at a depth to form a vein of workable width. The possibility, however, was discounted by the fact that in the fall of nearly 200 feet from the highest point of the outcrop to their intersection by Glen Creek, the veins maintained their parallelism and thickness.†

McMaster's Lode.—Portion 2, Parish Tent Hill, County Gough.

In 1875, G. H. Gower recorded a very large outcrop on the continuation of the Ottery range, in McMaster's property of 260 acres, close to Tent Hill, consisting of quartz and tin-stone, tin being found in the surfacing on both sides of this range. About 300 yards lower down the south side, another lode outcropped on a table-topped ridge, traceable for 150 yards, and of a width of 2 feet. It had been opened by a shaft 9 feet deep, and a trench 6 feet by 2 feet, and large blocks of tin-bearing lodestuff obtained.‡

David described McMaster's Lode as—

"Another branch from the Ottery Lodes. The strike varies from 17° degrees east of north and west of south to 23° north of east and south of west, the bearing of the reef conforming roughly to that of the margin of the great dyke (coarse hornblendic granite.—J.E.C.). This dip is 58° north-westerly. The veinstone is a gossany green felstone, traversed by quartz veins, and containing massive mispickel and tin-stone. The quartz veins are from $\frac{1}{8}$ to $\frac{1}{2}$ inch wide. Porphyrite forms the wall of this dyke mass on the south-east; to the north-west the mass is connected probably with the hornblende granite.§

This lode was also described by C. S. Wilkinson as 5 feet wide where opened at the surface, and consisting of—

"Porous, ferruginous, siliceous, and micaceous rock, with quartz-veins of irregular thickness up to 9 inches, containing tin. Near this there are other narrow tin-bearing veins, and about their outcrop much surfacing for tin has been done."‖

Murphy's Rock Shaft Lodes.—The Gulf, Parish Muir, County Gough.

Strike north 35° east in hard granite. Thickness, about 1 inch.

Murray's Lode.—North-west of Carr's Red Cross Lode, Parish Muir, County Gough.

A small pipe lode of 2 feet by 1 foot diameter. Occurs in well-defined joint in granite, but tinstone independent of it, in pipe-like form, following irregular course. Opened to 28 feet, when the pipe rose towards surface, About $2\frac{1}{2}$ tons extracted to 1908.¶

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* Ann. Rept. Dept. Mines, for 1883, p. 151. † Geol. Veg. Ck., 1887, pp. 122-123. ‡ Ann. Rept. Dept. Mines for 1875, p. 108. § Geol. Veg. Ck., 1887, p. 139. ‖ Ann. Rept. Dept. Mines for 1883, p. 149.
¶ From a small gully in portions 9 and 10, near this lode, some remarkable nuggets of pure cassiterite were found by J. H. Butchart, about 1879, weighing from 1 to 30 lb. each. Several tons were obtained in the shallow soil, but the lode was not discovered.

Nuggety Lode.—Portion 178, Parish Tent Hill, County Gough.

Described by David as a vein of chlorite and quartz, 3 to 6 feet wide, striking from 22° to 26° north of east and south of west. Tinstone was visible only in loose pieces.*

O'Donnell's Lode.—Portion 5, Parish Tent Hill, County Gough. Described by David as a continuation of one of the Ottery veins.

> "The vein strikes 20° east of north and west of south, dipping north-easterly, and is from 1 to 1½ feet wide. The veinstone is a gossany friable quartz, containing tin-stone, with black and green stains, due to decomposition of arsenical pyrites. The vein has been sunk upon to a depth of 15 feet."†

Ottery Lodes.—Portion 47, Parish Tent Hill, County Gough.

The first ‡ official record of this important lode was furnished by Mr. Warden Martin in 1882, whose authority was Mr. J. H. Reid, of the Tent Hill Smelting Works :—

> "On the Ottery lode, belonging to this firm (Glen Smelting Company —J.E.C.), about one mile northerly from the smelting works, eight men have been employed since the 1st July, 1882. These men have sunk two shafts to a depth of 100 feet each, besides doing other work, to prove the value of the mine.
>
> No. 1 Shaft, at a depth of 100 feet, was 5 feet wide, showing tin ore freely ; but large quantities of pyrites coming in, it was deemed advisable to discontinue operations at that point, and start a shaft on another part of the lode, where some very large specimens of oxide have been found. In opening out the seam at this place, a seam of almost pure tin was found, which was followed down to a depth of 60 feet, when a change of formation took place, and the stone, although still payable, became not nearly so rich. In hopes of recovering the seam of oxide, the shaft was continued another 40 feet, but without further success than proving the existence of good stone likely to yield on reduction 20 per cent. of metallic tin. The prospects on the whole of this property have been of so encouraging a character as to induce the firm to erect for trial crushing a small plant, consisting of a five-stamper battery, a separating jigger, and a circular buddle."§

The plant was later described as driven by a 20 H.P. engine, and embracing all the latest improvements for concentration, consisting of jiggers, separators, buddles, rotary tables, &c. ||

The progress of mining development is shown in the following extracts from the Mining Registrar's report for 1883 :—

> "*No.* 1 *Shaft.*—Depth 120 feet ; driven 30 feet at 60 feet level ; back stoped on gossan ore 2 feet wide. At 120 feet, lode 3 feet wide and pyritic.
>
> "*No.* 2 *Shaft.*—Depth 110 feet ; lode 3 feet wide. Driven 60 feet at 50-feet level, ore averaging 20 per cent. ; pyritic.
>
> "*No.* 3 *Shaft.*—Depth 26 feet ; lode 3 feet 6 inches wide.
>
> "Open cut 60 feet long 20 feet deep, lode similar to No. 1 shaft. Outcrop visible northerly for about 300 feet, width 4 feet ; tested by shafts in various places.

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* Geol. Veg. Ck., 1887, p. 126. † *Op. cit.*, p. 139. ‡ S. H. Gower noted its outcrop in 1875 (Ann. Rept Dept. Mines, 1875, p. 108). § Ann. Rept. Dept. Mines for 1882 pp. 76-7. || *Op. cit.*, 1883, p. 105.

Gov. Printer.

Ottery Tin Lode near Tent Hill.

Showing portion of outcrop and workings.

Gov. Printer.

Ottery Tin Lode, near Tent Hill.

"*No. 4 Shaft.*—Depth 15 feet; lode 2 feet wide, yielding 15 per cent. ore. Tunnel driven 40 feet, lode here 2 feet wide, and good all the way."*

It was also examined in this year by C. S. Wilkinson, who described it as "a dyke mass of micaceous eurite from 40 to 100 feet wide, with numerous quartz-veins running irregularly through it, but generally along it, containing tin ore; it seems to have several branch dykes also carrying tin ore. It strikes north 18° east, and underlies westerly at from 70° to 80°. There is much gossan on the surface, probably resulting from the oxidation of pyrites in the lode. In the main shaft on the crown of the hill at 50 feet, a vein from 2 inches to 1 foot thick of almost solid tin ore with brown spongy iron ore was struck, but at 60 feet it changed into quartz with less tin ore. At the surface a lump of nearly pure tin ore was found weighing 2 cwt. 1 qr. 24 lb. About 150 yards to the east is another euritic dyke more than 100 feet wide with quartz veins containing tin.

"On the west side of the main lode a shaft has been sunk 90 feet deep upon a lode 6 feet wide, containing tin mixed with blende, galena, arsenical and iron pyrites; and a few yards further west a quartz vein 9 inches to 13 inches thick has been opened with streaks of tin parallel with the walls of the vein; its strike is north 40° east.

"The country rock is porphyry, with orthoclase, felspar, and hornblende. The tin ore is very irregularly distributed through the veins, but as there is such a large body of lodestuff to open out upon, with judicious sorting a considerable quantity of payable crushing stone can be raised." †

In 1884 No. 1 shaft had reached a depth of 210 feet, at which level the stone was poor. The levels at 130 feet were extended 100 feet each way from the shaft, a little tin showing throughout.

"No. 2 shaft reached 180 feet, the lode averaging 6 feet in width for 75 feet from surface, thence on to 150 feet. The lode value was low, but an improvement was recorded thence on to 180 feet. The good stone was stoped to surface, only a sufficient block being left for security of shaft.

"No. 3 shaft reached 140 feet. In this shaft pyrites is abundant. Levels were driven at 50 feet.

"No. 4 Shaft, depth 80 feet, on a different lode to the west of the main line.

"No. 5 Shaft, about 2 chains west of No. 3, reached 100 feet, the lode averaging 2 feet in width, but low grade. Level driven northerly 50 feet at bottom.

"No. 6 Shaft, depth 35 feet on another western lode about 2 feet wide.

"No. 7 Shaft, depth 50 feet, also on a distinct lode 3 feet wide. Pyrites met at same depth as in No. 3.

"No. 8 Shaft, depth 40 feet, lode 7 feet wide.

"In addition to the shafts a large amount of open cutting was done which yielded some fair stone. The tunnel was also advanced 30 feet, the lode being here 2½ feet wide.

The total amount of lodestuff crushed at the Glen Smelting Company's battery during the year was 2,107¼ tons, yielding 110 tons 3 cwt., of tin oxide, equal to 5·2 per cent., mostly from the Ottery mine, but several trial crushings from other lodes are included.‡

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* *Op. cit.*, 1883, p. 105. † *Op. cit.*, p. 149. ‡ Ann. Rept. Dept. Mines, for 1884, pp. 97–8.

The 1885 record is briefly to the effect that fourteen men on an average were employed raising tin ore. From the Glen Smelting Company's returns of ore treated for this year 183 tons 16 cwt. 3 grs., 10 lb. are given as the output of the Ottery lodes.*

During 1886, the battery was continuously at work, mainly on Ottery stone; 2,419 tons 6 cwt. 3 qrs. yielding 79 tons of tin oxide; equal to 3·2 per cent. The tunnel was extended to 200 feet.

In 1887, the Ottery mine produced 2,171 tons 12 cwt. of lodestuff which yielded 76 tons 3 cwt. 1 qr. 18 lb. of tin oxide, equal to 3·5 per cent. The tunnel was advanced to 340 feet, and was expected shortly to intersect the main lode at 150 feet vertical below the surface.†

In this year David published the result of his observations during 1883–4, from which the following notes are extracted :—

> "The Ottery veins occur in dyke masses of hornblendic granite and eurite within 8 chains of the junction line of claystone, the main dyke being 100 feet wide in places."
>
> "The main lode had at that date been worked at the south end at intervals for a distance of 260 yards, to depths in the principal shafts of 122 feet, 75 feet, and 130 feet. The thickness of the lode being about 3 feet, consisting chiefly of drusy quartz, with oxide of iron, mispickel, and tin-stone. Below 45 feet from surface the oxides gave place to compact sulphides. The shoot of ore here, worked at 50 feet from the surface, measured 270 feet by 15 feet, and a width of from 4 inches to 1 foot, consisting of nearly solid tin-stone. At its lower end the shoot became nipped, a thin vein of quartz 1 to 2 inches wide marking the continuation of the vein. At the 130 feet shaft the lode averaged 3½ feet wide within well-marked walls showing slickensides. Oxides replaced by sulphides at 75 feet. At 60 feet from surface a level was driven south-west 110 feet, when the lode became pinched. North-east it was stoped for 40 feet from the shaft, when it was split by a 'horse' of granite, causing impoverishment. The lode at the point was tin-bearing for 135 feet horizontally, and averaged 3½ feet wide for 96 feet; the richest ore hugging the walls. The lode contained a fair percentage of tinstone, whilst the angle of dip was not less than 40°, but became contracted and impoverished as the dip lessened. The veinstone at 130 feet consisted of massive arsenical pyrites and drusy quartz, freely crystallized in vugs partly filled with iron and arsenical pyrites. In subsequently deepening this shaft to 180 feet, 3 tons of ore obtained between 150 and 170 feet yielded 20 per cent. of tin-stone. This rich shoot being on the line of dip of the shoot lost in the upper 122 feet shaft."
>
> "About 3 chains northerly from the 130 feet shaft, the lode has been worked in open quarry, the width of the lode being 3 to 5 feet. Footwall well marked; hanging wall less so. Tin-stone well disseminated through the mass of the vein stuff. The west branch of the lode was also worked by open cut, its width being 3 to 4 feet. Strike north 3° east; dip westerly; footwall uneven, but strongly slickensided Hanging wall fairly defined. Vein stuff friable, arsenical, ferruginous quartz and felstone; the tinstone being finely disseminated through the quartz, chiefly on the footwall.
>
> "The east branch of the main lode strikes from north 10° west to north 20° east. Dip westerly at 50° to 70°. Average width 3½ feet; footwall

* *Op. cit.*, 1885, p 93–4. † *Op. cit.* 1887, p. 87.

well-defined and slickensided; hanging-wall less defined. Veinstone, chiefly felstone with arsenical ferruginous quartz. Probably both branches will unite with main lode at a depth.

"*The Cross Vein* proved at intervals for a distance of 11 chains. Strike north 50° east, nearly vertical. Width about 5 feet; hanging-wall well-defined; no footwall. Veinstone quartz with mispickel and tin-stone. The latter runs in floors across the lode about 3 or 4 feet apart.

"*The East Vein* strikes north 20° east, dips westerly at 74°; average width 1½ feet. The tin-stone occurs in drusy ferruginous quartz, with a little chlorite.

"*The West Vein* strikes north 28° east. Underlie from 78° north-westerly to 78° south-easterly. Average width 5 inches; veinstone, friable ferruginous quartz rich in tinstone, and free from iron and arsenical pyrites."

"In summarising his views, David stated that the main lode had proved productive of tin for a distance of over a quarter of a mile, and for a vertical extent of 160 feet. 'The well-defined nature of the walls, the strong slickensides, and the quantity of clay flucan lining the veins, proclaim this to be a true fissure vein. It will be noticed that in all cases where the inclination of the vein from the vertical became suddenly lessened, it became pinched and unproductive, confirming the well-known experience of miners that those parts of a vein which most nearly approach the vertical are generally the richest."

"The strike of the veins follows approximately that of the junction line between the porphyrite and claystone. The dip, except in the case of the west vein, is north-westerly, following the underground line of junction between the crystalline rocks and the claystone, giving these ore bodies the character of contact deposits. The ore in these veins occasionally runs in shoots, which dip to the north-east, following, perhaps, the dip of the sedimentary rocks in the immediate neighbourhood."*

During 1888, work was carried on continuously, but the crushing plant was hung up owing to scarcity of water.†

In 1889, only 98 tons 17 cwt. of lode stuff were raised in the district. ‡

In 1890, 67 tons of tinstone were obtained from the Ottery mine§ out of 152 obtained from lodes in the division.

In 1891, the battery was constantly at work—1,747 tons of lodestuff treated from the Ottery mine yielded 75½ tons tin ore—equal to 4·3 per cent. Deepest level 210 feet.‖

1892 } No Departmental returns published.
1893 }

In 1894, 22 miners constantly employed. Lodestuff raised estimated at 1,108½ tons.¶

In 1895, 181 tons 6 cwt. of dressed ore obtained; seventy-six men employed. Twenty-five stamps in two batteries at work.**

In 1896, seventy men employed—10,678 tons of lodestuff raised, which yielded 360 tons of tin ore, valued at £10,981, equal to 3·3 per cent.††

1897—Ottery mine at work; no output given.

1898—Worked continuously during the year; 60 hands employed. The output of tin for the year was 161 tons 4 cwt. 3 qr. 3 lb., but the tonnage treated is not given.‡‡

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* Geol. Veg. Ck., 1887, pp. 140–143. † Ann. Rept. Dept. Mines for 1888, p. 116. ‡ *Op. cit.*, 1889, p. 105.
§ *Op. cit.*, 1890, p. 103. ‖ *Op. cit.*, 1891, p. 125. ¶ *Op. cit.*, 1894, p. 51. ** *Op. cit.*, 1895, p. 59.
†† *Op. cit.*, 1896, p. 47. ‡‡ *Op. cit.*, 1898, p. 73.

1899—Continuously at work ; ore roasted before treatment ; no returns quoted.

From the latter year until closing of operations early in 1906, the published Departmental references to the Ottery mine are brief and inconclusive. The Writer has, however, been supplied by Mr. J. H. Reid with the following statement from the late Company's books :—

"From 1st January, 1900, to 31st December, 1905, 17,032 tons of lodestuff were raised and crushed for a yield of 354 tons 9 cwt. 0 qr. 19 lb. of tin oxide (dressed to a standard of 70 to 72 per cent. metallic tin) equal to 2·08 per cent.

"The total cost of development, mining the lodestuff, roasting in open heaps, carting, crushing, and dressing; furnace roasting and redressing the concentrates, and drying and bagging the black tin, averaged 25s. 9d. per ton of lodestuff put through the battery, as follows :—

	£	s.	d.
"Development and mining lodestuff, per ton	0	13	3
Roasting ore in piles or clamps, by contract, per ton ...	0	1	0
Carting to battery, by contract, per ton	0	2	9
Battery charges, covering all costs other than redressing concentrates, per ton	0	6	6
Roasting concentrates and redressing, per ton	0	1	6
Drying and bagging, including bags, per ton	0	0	9
	£1	5	9

The total output from the Ottery Mine, from 1883 to 1905, has been computed by Mr. Reid from the mine records as follows :—

Year.	Tinstone.			Tin Ore.				Value.		
	tons	cwt.	qr.	tons	cwt.	qr.	lb.	£	s.	d.
1883	283	6	0	13	12	1	7	678	11	5
1884	1,751	10	2	85	2	3	15	3,484	14	3
1885	1,427	4	1	57	18	1	11	2,920	11	0
1886	2,419	6	3	80	18	0	21	4,549	0	3
1887	2,171	12	0	76	3	2	0	5,063	11	7
1888	2,328	7	0	92	14	0	13	6,259	7	11
1889	1,699	9	0	54	18	0	23	2,799	19	7
1890	1,314	17	2	43	16	0	4	2,685	18	6
1891	1,446	17	0	63	16	2	25	3,153	12	6
1892	4,832	15	0	140	3	2	8	7,228	19	8
1893	7,534	0	0	188	7	2	11	8,109	6	8
1894	8,766	0	0	262	19	3	0	9,040	11	10
1895	3,038	6	2	91	3	2	2	2,999	8	3
1896	10,742	7	0	379	10	1	20	10,965	15	11
1897	6,765	0	0	202	19	2	7	6,351	4	3
1898	5,555	6	0	161	4	3	3	6,210	1	9
1899	5,162	0	0	129	1	0	24	8,935	1	9
1900	6,020	0	0	120	7	3	24	8,882	1	5
1901	3,162	0	0	76	1	0	1	4,915	4	10
1902	1,538	10	0	31	10	0	12	2,353	13	11
1903	2,039	0	0	41	3	1	1	3,157	3	6
1904	2,154	0	0	43	17	2	16	3,089	2	0
1905	2,118	10	0	41	9	0	21	3,391	18	1
Totals	84,270	4	2	2,478	19	3	17	£117,225	0	10

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Ore dressing and concentrating plant, Glen Smelting Works, Tent Hill.

Paradise Lode (Blue Lode).—N.E. corner portion 54, Parish Flagstone, County Gough.

Examined by David in 1883–4 :—

"Strike north 35° east. Outcrop over 30 feet wide, consisting of chlorite and quartz, coloured deep reddish-brown from oxidation of iron in chlorite, and of the iron pyrites contained in the veinstone. The latter is chiefly composed of chlorite, with quartz distributed through it in imperfectly formed crystals, and in small drusy veins. Iron pyrites occur crystallized, associated with mispickel. The actual width of vein is about 10 feet. Tin ore was reported to have been found, but the above authority was unable to detect any in the spoil bank round the shaft, which had been sunk 95 feet.*

This lode was reopened in 1909, the shaft being continued to 70 feet, but the tinstone is reported to have given out at 50 feet. Mispickel was then making.

Portions 90 *and* 92.—Parish Land's End, County Gough.

David also describes lodes occurring in these portions :—

"In portion 90 a vein strikes north 76° west, dipping northerly at 73°. Veinstone quartz, felspar, and a variety of red stilbite, resembling heulandite. A shoot of tinstone in heulandite, from 1 to 3 feet wide and 4 feet deep, was followed down from the surface to a depth of 20 feet for a horizontal distance of 27 feet, producing 3 tons of ore. The shoot pitched easterly.

"Near the south-west corner of portion 92 is a vein of solid tin-stone in very hard aplitic granite, close to the boundary of claystone. Strike north 35° east. At Hamilton's shaft, in the same portion, 25 feet deep, a shoot of ore was found on the strike of this vein 1 foot wide and 2½ feet deep, pitching to the north-east. Veinstone, white felspar; yield, ½ ton of tinstone."†

Portion 19.—Parish Muir, county Gough—two lodes are described in the same work :—"The north vein strikes north 40° east, dipping north-westerly, 3 feet wide in places. Walls not well-defined; country hard granite; shaft, 20 feet deep, vein at bottom of shaft carrying ore."

"Two and a half chains south of preceding, a vein strikes north 39° east, nearly vertical; average width of tin-bearing veinstone, 3 inches; composed of quartz and tin-stone in open-grained granite porphyritic by felspar."‡

Red Cross Lode.—Portion 18, Parish Muir, County Gough. It is recorded that the lode in this portion was being prospected in 1883.§ 4 tons 11 cwt. of tin-ore had, however, been won by Chinese from the alluvial in close proximity.‖ Work was in progress in 1884. In 1885 a new lode was struck over 1 foot thick with almost pure tinstone.¶

In 1887 David recorded the following note on the original discovery from observations made in 1883–4 :—

"*Red Cross Lode* . . . strikes north 43° east, dipping 85° north-westerly, average width, 2 inches. The vein consists of nearly solid tinstone, replaced occasionally by quartz and chlorite. The tinstone is black, deep-red, resin, and translucent. The ore at the centre of the vein is coarsely crystalline, but becomes finer towards the walls. The footwall shows slickensides. The vein is encased by hard quartzose granite. At the bottom of a shaft on the vein, 35 feet deep, the vein was 1 foot in width."**

This lode was worked for a horizontal distance of 100 feet and a depth of 35 feet.

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* Geol. Veg. Ck., 1887, p. 118. † *Op. cit.*, p. 116. ‡ *Op. cit.*, p. 112. § Ann. Rept., Dept. Mines for 1883, p. 103. ‖ In 1908 a rich shoot was discovered in the bedrock, 25 tons of dressed tin-ore being obtained from a length of 60 feet. The principal yield, however, being from a length of 15 feet by a width of 3 feet. No work done below 30 feet from surface. ¶ Ann. Rept. Dept. Mines for 1885, p. 93.
**Geol. Veg. Creek, 1887, p. 111.

Strathbogie Paddock Lode, portion 20, Parish Strathbogie, County Gough. David describes a lode in this portion, striking north 15° east, the outcrop having a width of 6 to 10 feet, the veinstone being chloritic felstone, with strings of quartz containing tinstone and mispickel. The casing rock is felspar-porphyry. This lode had not then been prospected, but was worthy of test. One mile south, in the same portion, a strong outcrop of gossan marks its prolongation in that direction.*

Taylor's Lodes.—Portions 68 and 71, Parish Bundar, County Gough. Described by David in the following terms :—

> " Taylor's veins, on the Glen Creek, three in number, are situated in portions 68 and 71. . . . The geological character of the country near these veins is somewhat singular. Three oval masses of granite, from 4 to 10 chains in diameter, have burst through the claystone at a distance of 2 miles south of the junction line of the granite and claystone. These dykes of granite are traversed by tin-bearing veins, which continue to be stanniferous as long as they are enclosed in granite, but where the casing rock is claystone the tinstone is replaced by mispickel, molybdenite, and probably by bismuth, as small nuggets of that metal have been found in the alluvials."†
>
> "In portion 68, a vein strikes north 38° east, dipping to the south-west. Said to be 8 feet wide—veinstone ferruginous gossan and comby porous quartz, the cavities being filled with raddle and a little tin-stone. The tin ore in the vein was said to be dipping in a shoot south-westerly. 5 chains south of this shaft tin-bearing veins occur in circular patches of greisen, surrounded by claystone. The greisen is composed of quartz and pearly chlorite or greenish mica. The tin-stone runs in floors and pockets in the vein stuff, generally massive, but also in well-formed crystals, ½ inch in diameter."
>
> In portion 71, in the same parish, a vein from 1 foot to 1½ feet wide strikes north 80° east. The veinstuff, which is felspathic and of a greenish colour, with scales of lepidolite, contains small well-formed crystals of tinstone."
>
> " In the same portion, north of the preceding vein, is another vein 1 foot wide, striking 21° north of east and south of west. The vein consists of quartz and mispickel, with molybdenite and probably bismuth. The casing is claystone. This locality is very promising, and is worthy of being prospected, especially near the main gossany vein."‡

Wallaroo Lode.—Portions 169, 170, 171, 300, 301, 302, and 304, Parish Highland Home, County Gough. Discovered by Trewheellar and party. First officially recorded in 1882, and described as striking about north-east. Width averaging 3 feet 6 inches. Little more than prospecting had then been done. Two distinct lodes are reported in the portion ; payable tin-stone being obtained from the soil near the lodes.§

Opening up work continued for a time in 1883, then ceased pending negotiations for sale.‖

In 1884 the lode was prospected by Bray and Sons, who sank to 30 feet, where the width averaged 12 inches. Seventeen tons of lodestuff crushed at the Glen Smelting Company's works, Tent Hill, yielded 2¾ cwt. of tinstone to the ton.¶

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* Geol. Veg. Ck., 1887, p. 127. † *Op. cit.*, *p.* 131. ‡ Geol. Veg. Ck., 1887, pp. 131-2.
§ Ann. Rept. Dept. Mines for 1882, p. 89. ‖ *Op. cit.*, 1883, p. 104. ¶ *Op. cit.*, 1884, p. 98.

David described the Wallaroo lode as having been traced through the portions mentioned, and regarded it as probably a continuation of one of Taylor's lodes. The normal strike is N. 50° E., a change of bearing to N. 40° E. being due to a northerly heave. Dip, 60° south-easterly; width, 1 to 4 feet, averaging 1½ feet. The mode of occurrence is described either as a "central crack, the sides of which are lined with vein-stuff merging into granite, or of a veinstone enclosed between well-defined walls. At the north-east end of the workings (which extended for a distance of 6 chains and a depth of 25 feet.—J.E.C.), the vein has good foot and hanging-walls, showing slickensides, the vein-stone being separated from the hanging-wall by a selvage of clay flucan, 1 inch thick. The surrounding granite, which is fairly soft, is slightly porphyritic by quartz, and consists of quartz, biotite, orthoclase, and triclinic felspar. The quartz occurs in large or small rounded or irregular-shaped blebs. The felspar crystals are yellowish grey, with a greenish tinge, and have indistinct outlines. The vein-stone is composed of quartz, chlorite, and mica (?). The quartz is rather glassy, and full of minute hollows, ¼ inch diameter, containing well-developed quartz crystals and tin-stone. The ore is fairly well mixed through the stone, but occurs principally in small veins of quartz, ½ inch thick, traversing the mass of the vein-stone. . . . "The strong strike of this vein, its great horizontal extent, and the richness of the vein-stuff invite further prospecting."*

Willcox's Lode, near Graney's Lode.—Parish Land's End, County Gough. (See Yankee Lodes.)

Yankee Lodes.—Portion 99, Parish Land's End, County Gough. The first official record appeared in 1878. The owners, Messrs. Willcox, Webb, and party, had commenced active operations on the lode, which gave considerable promise.†

In 1879 prospecting was still in progress, the surfacing affording them profitable employment.‡

It is probable that the ground being worked by Messrs. Graney and Co. in 1882 is identical with the above. Of the latter it is recorded that a shaft had been sunk 15 feet through hard rock, exposing a rich vein about 15 inches thick. Another shaft, 33 feet deep, about 200 yards distant, proved a lode 2 ft. 6 in., wide, showing tin from the surface down, six men being employed on the lodes and eight in the alluvial from them.§

In 1883 that the same Company had two parties of Chinese tributing on the Yankee (Block 99), and it was reported that £100 per month clear was being made, in spite of water scarcity.‖

In this year the locality was examined by C. S. Wilkinson, who described the Yankee lode as "a ferruginous quartz-vein 4 inches thick, with chlorite and tin ore; it has been traced for about 500 yards, and strikes N.E. and S.W., traversing porphyritic granite. A prospecting shaft has been sunk upon it to a depth of 30 feet. On the south-east side of it, 12 yards from it, is a parallel vein, which is 2 feet thick in places. It contains crystals of quartz, felspar, and tin oxide, and has been worked to a depth of 25 feet. Another similar parallel vein, 28 yards from it, has been worked to a depth of 30 feet, when it made into white quartz containing but little tin. Within 100 yards are four narrow tin-bearing veins not worked. On the west side of the Yankee vein are several narrow quartz-veins running west 25° north, and containing molybdenite and chlorite.¶

* Geol. Veg. Ck., 1887, p. 132. † Ann. Rept. Dept. Mines for 1878, p. 129. ‡ *Op. cit.*, 1879, p. 154.
§ *Op. cit.*, 1882, p. 91. ‖ *Op. cit.*, 1883, p. 102. ¶ *Op. cit.*, 1883, pp. 149, 150.

David described these lodes as they appeared in 1883–4, when he examined the district :—

"Three principal veins, worked in portion 99, may be distinguished as west, middle, and east. The west vein, averaging 1 foot in width, strikes north 44° east, nearly vertical. Vein-stuff consists of quartz, chlorite, and tinstone, and is tin-bearing for a width of 2 inches. Walls not defined; shaft, 20 feet deep.

"*Middle vein*, from 1 to 1½ feet wide, strikes north-east. Veinstuff similar to preceding. Tin-stone occurs in beautifully-formed crystals in the quartz, and is distributed through the vein in the form of a shoot, pitching easterly. Shaft, 20 feet deep; yield, 6 tons of ore."

"*East vein*, averaging 1¼ feet in width, strikes north 55° east, and has been traced on the surface for 4 chains. In a shaft sunk on the reef in Wilcox's garden, at 15 feet from the surface, a large vug was found 2 feet long, 2 feet deep, and 1½ feet wide, the sides being lined with magnificent crystals of tin-stone and clear quartz. In some specimens the tin-stone invests the quartz, while in others it is enclosed in it, showing that the silica and tin must have been in solution simultaneously. This vein appears to be the champion of the three, and is worthy of being further prospected. A small quantity of molybdenite is associated with the tin ore in these veins, and the clear quartz is occasionally wrapped in a thin covering of milky quartz, forming "quartz *en chemise*." Close to the preceding are four smaller veins having nearly the same strike, making a total of seven veins in a space of 200 yards."

"In portion 32, in the same parish, are three veins. Somer's, the southern vein in the portion and a continuation of the East Yankee, strikes north 35° east, dipping 70° north-westerly. Width, 10 inches; veinstuff, quartz, with pearly chlorite (?), containing good ore at its point of intersection with a cross-vein of quartz, the latter being about 6 inches wide, and nearly vertical, striking north 60° west. At this point a small shoot of tin-stone, 1 inch wide and 6 inches deep, worked to a depth of 17 feet, yielded 1 ton of ore. The granite country is fairly soft, and as the reef is on the strike of the Champion Yankee vein it should be further prospected.

"The north vein in the same portion strikes north 20° east, dipping 80° north-westerly. A shoot of ore was got in a shaft 8 feet deep, measuring 7 feet long by 3 to 4 inches wide, and pitching easterly. The tin-stone occurs in a greenish quartz, lining the sides of a crack in the granite."*

What is now known as Clifford's mine is the north-east end of the Yankee lode. Here it has been opened for about 250 feet horizontally, and to 67 feet in greatest depth. The tin-stone occurs in the usual chloritic quartzose veinstone, and is richest where the vein is thinnest; where widest, it occurs disseminated in threads through the veinstone.

(*b*)—Deepwater Division.

Alluvial.

Bald Rock Creek.—Parish Binghi, County Clive.

"At Bald Rock Creek . . . . stream-tin sands and gravels have been worked to a depth of 10 feet on to the granite bottom. The beds consist of subangular and round quartz sand with fragments of quartz veinstone, granite and claystone, the largest being 6 inches in diameter.

* Geol. Veg. Ck., 1887. pp. 114–5.

The stream tin, which is well rolled, is chiefly black, with a fair sprinkling of resin and ruby and a little grey or brown ore. The largest are a $\frac{1}{4}$ inch in diameter, the average gauge being $\frac{1}{12}$ inch." *

Blather Arm, or Blather Creek, a tributary of Oaky Creek.—Parish Bate, County Clive.

"The sand and clay in these alluvial workings, in portion 42, ... are from 10 to 15 feet deep, and consist of subangular granite sand with subangular and round quartz pebbles up to 6 inches in diameter, and rest on a bottom of granite. White topaz and sapphires are very abundant. The stream tin is chiefly black, but resin and ruby tin is sparingly present. The grains are much water-worn, sharp crystals being the exception. The largest of the grains are $\frac{1}{4}$ inch in diameter."†

Work in this creek evidently commenced early in the seventies, as the Mining Registrar reported in 1875 that it, amongst others, had been worked more or less profitably, "but all large operations in tin raising have long since entirely ceased, both on account of the fall in the tin market, and also the very limited supply of water usually found on the Tableland."‡

Carney's Hill, Portion 269, Parish Wellington Vale, County Gough, $4\frac{3}{4}$ miles west of Deepwater.

In this portion near Carney's Hill, three shafts were sunk in close proximity through hard basalt for the most part. A very little coarse water-worn wash with coarse water-worn black tin and numerous zircons occurred on a bottom of soft granite; but the results were not sufficiently encouraging to prompt further effort. It is probable that the tin obtained here is identical with the discovery recorded by the Mining Registrar at 60 feet deep under basalt.§

Catarrh Creek, Parish Annandale, County Clive.

In 1875 the Mining Registrar reported that this creek had been very profitably worked, a considerable amount of tin being obtained from it; the ground, however, had become too deep and wet for small parties.‖

David described the locality in the following terms :—

"The shallow recent alluvial beds here have a length of about 1 mile, extending down the left bank of the creek from portion 14 to portion 24 in the same parish. The width varies from 3 to 7 chains, and the depth to the granite bed-rock from 10 to 14 feet. The constituents are clean granite sand with round and subangular pebbles of quartz, granite, and greisen, up to 5 inches in diameter. A few well-rounded Tertiary pebbles were observed in these gravels.

"The stream tin is mostly black, but resin and ruby varieties are also present. The grains are very much waterworn, unbruised crystals being very rare; the average diameter of grains is $\frac{1}{20}$ inch.

"The deposit evidently consists partly of Tertiary sands and gravel, re-deposited in recent geological times; 1,000 tons of stream tin are said to have been obtained from these alluvials."¶ **

Hamilton's Gully, Parish Angoperran, County Clive. North of Portion 190 about $\frac{1}{4}$ mile. Worked by J. Hamilton about 1884, and occasionally by fossickers since. Several tons of coarse resin and ruby tin have been won

* Geol. Veg. Ck., p. 70. † Ibid, p. 70. ‡ Ann. Rept. Dept. Mines for 1875, p. 107. § Ann. Rept. Dept. Mines for 1880, p. 161. ‖ Ann. Rept. Dept. Mines for 1875, p. 107. ¶ Geol. Veg. Ck., 1887, p. 69. ** A dredging plant was installed in Catarrh Creek in 1909, but the enterprise proved unprofitable.

from this gully. The tin has evidently been derived from several small tin veins near its head. The alluvial is derived from, and rests upon, granite. (See also Stannum King Mine).

Moleyard Creek, a tributary of Oaky Creek. Parish Bates, County Clive.

> "The stanniferous gravel is similar to that of Blather Arm, with the exception that it contains pebbles of claystone, derived from a neighbouring outlier of that rock."*

Nine Mile Deep Lead, Portion 520, Parish Wellington Vale, County Gough.

> "In portions 520 and 521 in the same parish, tin gravels, probably of Pleistocene age, cover granite and basalt to a depth of at least 20 feet. The deposit consists of coarse subangular granite sand, with subangular lumps of reef quartz containing tinstone, from 4 to 5 inches in diameter. Very few well-rolled Tertiary pebbles are met with. The stream tin is more worn than in the recent gravels, and contains more black tin. The average diameter of the grains is $\frac{1}{15}$ inch. A shallow lead has been worked in portions 520 and 521, where the lead rests on a bed of older soft basalt, and apparently skirts the margin of the hard basalt."†

In 1900 aid was granted from the Prospecting Vote for testing the deeper ground in Portion 520. Bed-rock was reached in 1901 at 180 feet with a dip to the east. A drive following the dip was extended 120 ft., all through coarse drift, with a small quantity of fine angular black tin. The end of the drive was 20 ft. below the shaft bottom. The flow of water amounted to 2,000 gallons per hour. The following section was exposed in the shaft:—

60′ decomposed basalt.
100′ hard basalt.
20′ coarse sandy drift, with a little fine tin.
Soft granite bedrock.

Piercey's Hill, about 5 miles north of Deepwater, Parish Romney, County Clive. The hill is capped with about 60 ft. of basalt, a remnant of the previous extension of the Stannum Vale flow, which here covered an early drainage channel, now represented by the isolated patch of stanniferous gravel preserved under the basalt cover. The hill has an elevation of about 300 feet above the Deepwater River at its eastern foot.

Mining operations began at Piercey's Hill about 1875, and have been prosecuted at long intervals since. In 1881 Partridge and party bottomed at 50 feet on fair prospects, which, however, were not realised, for the bottom proved very uneven in the drives, with here and there holes containing rich wash.‡

In 1891 a company was floated and machinery erected.§ The most important developments were carried out by the McDonald Syndicate, beginning about 1894. A tunnel was driven into the hill 400 ft. northerly, and numerous cross-drives put in from the main tunnel. As the wash continued to dip westerly into the hill, and water being troublesome, a tunnel was started from the west side to meet the eastern, but it had to be abandoned at 100 ft. owing to the steep dip of the wash easterly. The syndicate also sank a shaft 7 chains north of the main tunnel, and connected it with the latter by cross-cut. This shaft passed through 50 ft. of hard basalt, requiring explosives.

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* Geol. Veg. Ck., 1887, p. 70. † Geol. Veg. Ck., 1887, p. 68. ‡ Ann. Rept. Dept. Mines for 1881, p. 101. § *Ibid.* 1891, p. 119.

Gov. Printer.

Stannum Vale Deep Test Shaft.

These workings exposed the following strata :—

60′ hard basalt.
20′ somewhat coarse, reddish, sandy drift, with a few small water-worn quartz pebbles, and a little fine partly-worn black tin.
2 to 3 inches white pipe-clay, yielding no tin.
3 ft. mostly medium-sized quartz wash, with occasional large quartz boulders, the yield of tin increasing with quantity of stone present in the wash. Averaged ¼ cwt. coarse water-worn red and black tin ore per load.
Soft porphyry bottom southerly ; granite, northerly.

The McDonald Syndicate continued operations for about eighteen months. The wash was conveyed by an aerial tramway, 700 ft. long, to "The Coppers' " Gully, and treated at a washing plant erected on MT. 1.

Messrs. Brown Bros. drove other tunnels on the western side, the principal known as Lawson's, after the manager. At least 60 tons of tin ore are known to have been won from this site, but the total yield is probably considerably greater. The bulk was obtained from the northern half of the hill. Some very rich deposits were found, but the general character of the yield was uneven, the wash being patchy. The grade of the dressed tin ore was high.

"Coppers' " Gully, draining Piercey's Hill on the east side, was worked for tin ore derived from the denudation of the outcrop of wash on the side of the hill. The redistributed tin ore occurs from the surface to 3 ft. in depth, resting on granite bedrock.

Stannum Vale Deep Lead (formerly known as Nine Mile), Parish Wellington Vale, County Gough, falls in a southerly direction (according to the basalt flow) from the village of Stannum, beginning as shallow alluvial, and gradually passing under basalt into deep ground.

Of the shallow ground David in 1887 wrote :—

> "The recent workings here are located chiefly between portions 71 and 65, Parish of Wellington Vale, where they have a length of 60 chains, a width of 2 chains, and a depth of from 3 to 14 ft., the average depth being 7 ft. The beds are composed of ferruginous clay, with quartz sand, and fragments of felspar crystals. The thickness of the wash, which rests on a bed of porphyrite, varies from 6 in. to 2 ft. The average yield is about 20 lb. of ore per cubic yard of wash-dirt. Patches measuring ½ x ½ chain have yielded 2 tons of stream tin, but this richness is very exceptional.
>
> The tinstone is chiefly yellow and resin, with a fair percentage of ruby and black ore. The grains are mostly much worn, with a few sharp fragments interspersed. The size of the grains varies from that of a fine dust to ¼ in. in diameter, the average size being $\frac{1}{20}$ in. in diameter.
>
> Associated with the tin ore are quartz, zircon, and spinel. A similar quality of ore occurs on the surface near south-west 119, where the crystals are very sharp and angular. Stream tin in the Nine Mile Creek has evidently been derived from this source."*

Bates' Shaft, sunk in the basalt near its western margin, in portion 72, bottomed at 116 ft., after passing through 25 ft. of alluvials below the basalt.†

Under the head of *Wellington Vale Lead*, David discussed the basalt-covered channels trending north and south from a hidden water-parting beneath the basalt sheet, approximating to the present divide between the Nine Mile and

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* Geol. Veg. Ck., 1887, pp. 67, 68. † See David's Map.

Pye's Creeks. Two basalt flows are indicated at the northern end, and anticipated at the southern, east of Bates' Shaft, in Portion 72. The recent deep test in portion 94, Parish Wellington Vale, has actually proved three flows, separated by drift material. (See Section opposite.)

In view of the importance of the latest provings, David's notes are given in full :—

"The portion of this lead which comes within the area of the tin-mining reserve has a length of $6\frac{1}{4}$ miles, and a width of from $\frac{1}{2}$ to 2 miles. The broad features of this lead are shown on horizontal and transverse sections of Section No. 8. The existence of two flows of basalt here is very apparent, and consequently there will probably be two corresponding leads. Both flows have a meridional trend, and the lava streams probably emanated from the stunted lava cones at the north-east end of the parish of Wellington Vale. The thickness of the upper sheet near this point cannot be less than between 200 and 250 feet, and that of the lower sheet about 100 feet. Outcrops of sand and gravel were observed by me at or near the northern extremity of the lead ; one about 6 chains west of the north-west corner of portion 91, Annandale, a very coarse quartz-gravel, pebbles being between 4 and 5 inches in diameter. As landslips appear to have occurred here, this gravel may not be *in situ*. At a somewhat higher level, in portion 91, a tunnel has been driven into the side of the hill by Chapman and Davidson, and earthy quartz sands reached under the basalt. I was unable to obtain any tin from these sands, but they are not by any means so favourable to the occurrence of stream tin as the coarser gravel in the lower outcrop.

The third outcrop bears west 23° north from the south-east corner of portion 534, Annandale, 15 chains distant. A seam of well-worn quartz sand is seen here in the right bank of the creek, resting on a bottom of granite, and capped by prismatic basalt belonging to the older flow. As this outcrop is approximately on the same level as the coarse gravel in portion 91, Annandale, the probability is that the sand at this third outcrop is near the main and older channel. Leaves of land plants are very abundant in the clays at Bates' shaft, in portion 170, Wellington Vale (? 72 J.E.C.), and also in some shafts bearing 25 chains north-easterly from the north-west corner of portion 534, Annandale. The deep-lead alluvials here are therefore probably of fluviatile origin. A water-parting probably exists underground near the present water-parting between the Mole and Glen Rivers. The shallow workings on the western side of this lead have not proved rich, having yielded up to date about 70 tons of stream tin. It must be remembered, however, that the area drained by the present Nine-mile creek is smaller than that which discharged its water into the old Wellington Vale streams ; for the volcanic material having been piled up here to a thickness of over 400 feet, the old valley must have been obliterated. The most favourable points for prospecting this lead would be :—

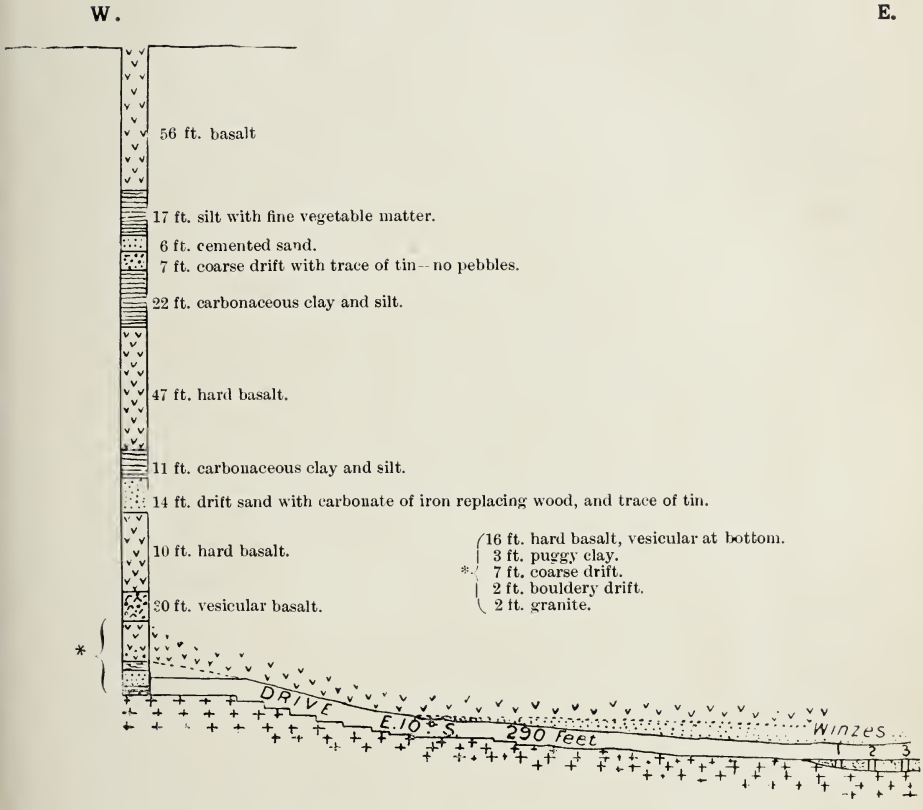
(*a*) Commencing from the third outcrop, and going south-westerly.

(*b*) Commencing near the south-east corner of portion 535, Annandale, and carrying on the prospecting in a direction west by north.

All this lead north of portion 66, Annandale, is well worthy of being prospected. The sinking, however, to catch the lowest channel will be deep—between 300 and 400 feet."*

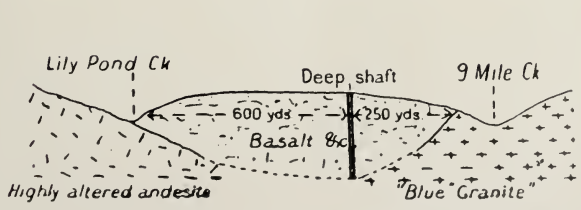
* Geol. Veg. Ck., 1887, pp. 107–109.

Stannum Vale Deep Test Shaft and Drive.*


W.
E.
56 ft. basalt
17 ft. silt with fine vegetable matter.
6 ft. cemented sand.
7 ft. coarse drift with trace of tin—no pebbles.
22 ft. carbonaceous clay and silt.
47 ft. hard basalt.
11 ft. carbonaceous clay and silt.
14 ft. drift sand with carbonate of iron replacing wood, and trace of tin.
10 ft. hard basalt.
30 ft. vesicular basalt.
16 ft. hard basalt, vesicular at bottom.
3 ft. puggy clay.
7 ft. coarse drift.
2 ft. bouldery drift.
2 ft. granite.
DRIVE
E. 10° S.
290 feet
Winzes
1
2
3

Section of Face at 3rd Winze.

Sketch Section.



* Section of shaft supplied by Mr. F. W. Thomson.

The channel proved by the Stannum Vale deep test shaft, in Portion 95, was much larger and stronger than the present. Unfortunately only the slightest traces of tin were obtainable from the abundant channel drift during driving operations in it for over 365 feet.

As the head of the lead was not remarkably rich, and the down-stream country non-stanniferous, the prospect was never encouraging at the site chosen, for only the finest tin grains would have drifted so far from their source in Battery Mountain. Even at the stream-heads, where the heaviest deposits would have concentrated, the yields were never comparable with those of leads like Vegetable Creek.

The nature of the sinking and driving at Stannum Vale Deep Shaft are illustrated in the following section and plan.

Tucker Gully, Portions 277, 278, Parish Annandale, County Clive :—

> "A swampy flat, having a length of ½ a mile, and a breadth of ¼ of a mile, has been worked for stream tin. The bulk of the deposit is probably pleistocene, but on the left bank of the creek a small area is occupied by recent gravel, which is coarser and more angular, contains more brown tin, and is looser than the pleistocene gravels. The general surface of the latter is 5 to 6 feet higher than that of the former. The pleistocene beds are from 10 to 20 feet thick, the average thickness being 14 feet, and consists of fine white and yellow quartz sand, with lenticular patches of coarse granite sand and fine dark sandy clay, and rests on a bed-rock of granite. The wash, which shows current bedding in places, occurs in patches from 6 inches to 3 ft. thick, and consists of quartz sand and sub-angular fragments of quartz 1 in. in diameter, a few containing reef tin. The average yield of ore is about 30 lb. per cubic yard. The tin is chiefly black and subangular, with a fair admixture of resin and ruby ore. Some of the grains are much water-worn, others have very sharp edges, evidently not having travelled far from their original matrix."*

Deepwater Division.

Lodes.

Bark Hut Lode.—(See Stannum Lode.)

Battery or Catarrh Mountain.—Parish Annandale, County Clive. Height above sea level 3,970 ft. by aneroid.†

Numerous tin veins occur in this mountain. A battery of seven stamps was erected in the early days of the field—on the eastern fall towards Stannum. David recorded the fact that "the thin veins of quartz and tinstone here are far too numerous to admit of their being plotted on the Geological Map, the greater part of the northern and north-western slopes of the Battery Mount being a vast stockwork."‡

Battery Mountain Company's Whim Shaft.—Parish Annandale, County Clive. Sunk to 150 ft. level in early days of field, reopened in 1908 by the Stannum Lode Company, and timbered to 100 ft. level. Levels driven north 63 feet., and south 79 ft. in quartz lode 3 ft. wide, carrying a little tinstone. Strike N. 40° E. Crosscut west 45 ft. through hard granite. 18 tons treated by the Stannum Company yielded less than 1 per cent. of tin ore.

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* Geol. Veg. Ck., 1887, pp. 63, 69. † Geol. Veg. Ck., 1887, p. 15. ‡ *Op. cit.*, p. 135.

Black Swamp Lodes.—Parish Rock Glen, County Clive.

"There are two principal veins here which may be distinguished as the west and east veins. The east vein commences in portion 405, as a small tin-bearing quartz vein with a little mica, 3 to 4 inches thick, striking about 30° east of north and west of south.

"Near the south-west corner of portion 408 a shaft has been sunk 43 ft. deep on an irregular vertical vein of quartz, striking 40° east of north and west of south. The quartz veinstone is separated from the granite by a soft white micaceous clay 1 in. thick. A small shoot of ore was said to have been got at 20 ft. from the surface. The vein did not appear to be tin-bearing at the bottom of the shaft.

"The same vein has been picked up again near the south-west corner of portion 397, in the same parish. At the south shaft here, 20 ft. deep, the vein strikes 40° 30′ east of north and west of south, having an average width of 8 inches. The veinstone is hard quartz, replaced by tinstone occasionally, and traversed by a central crack, on either side of which the quartz passes into a quartzose granite, containing dark mica, and slightly porphyritic by orthoclase. The granite, which is traversed by dykes of eurite, proved soft to a depth of 12 ft. when it became very hard. Near the bottom of the shaft was a shoot of solid tinstone 4 ft. long and 8 inches wide.

"At 38 chains further along the vein, in a direction 38° east of north and west of south, the vein was proved to be from 2 inches to 2 ft. wide, composed of greisen, quartz, chlorite, and muscovite, the tinstone occurring chiefly in minute vughs.

"From between the next two shafts to the north-east 8 tons of ore are said to have been won in a horizontal distance of 20 ft., at a depth of 18 to 20 ft. below the surface.

"At the north shaft in the same portion, 12 ft. deep, the vein consists of porous black glassy quartz, poor in ore, from 1 to 2 ft. wide.

"Three and a half chains easterly from the last point is the east vein, coursing 42° east of north and west of south, with a slight underlie north-west. The vein has been proved for a horizontal distance of 45 yards, and to a depth of 15 ft. Average width 1½ ft. Veinstone friable cellular quartz with nests of tourmaline and chlorite, small bunches of tinstone, and a little wolfram. The country is similar to that enclosing the preceding vein, but softer. 16 chains north-north-east from here, near the southern north-east corner of portion 402, Parish Rockglen, a vein, possibly a continuation of the last vein, strikes 26° east of north and west of south, is nearly vertical, and varies in width from ½ ft. to 1 ft. Veinstone, quartz, felspar, and pearly chlorite and mica.

"In portion 401, in the same parish, a small cross-vein ½ ft. to 1 ft. wide strikes 25° north of east and south of west.

"In portion 165 in the same parish, a thin vein of quartz and tinstone strikes 26° east of north and west of south. A shoot of ore has been worked here 6 ft. long and 5 in. wide. The ore was pinched at the upper and lower end of the shoot, the continuation of the vein being marked by a thin vein of quartz, filling a joint in the granite. The vein has been traced for 5 chains towards the north-north east. One ton of ore was obtained from the preceding shoot in an excavation 8 ft. deep and 6 ft. long."*

* Geol. Veg. Ck., 1887, pp. 121, 122.

Boomerang Lode.—Parish Wellington Vale, County Gough. At east head of Bark Hut Creek. Opened by Le Francke and Devlin about 1887. Strike from N. 15° E. to N.E., hence the name; dip, N. 55° W.; thickness, about 3 inches. Rich patches occurred averaging 7 cwt. to the ton. Veinstone, chlorite and quartz, with tinstone, in hard aplitic granite. Foot-wall well defined. Opened by deep cut, driven from this for 50 feet. Very rich patches of ore occurred where the strike varied. About 100 tons of tinstone are reported to have been won from this lode; also a moderate amount of alluvial from a well-defined trail from it.

Brady's Lode.—1¾ miles N.N.W. of Stannum, Parish Wellington Vale, County Gough, on Battery Mountain, 4 chains S.E. of Gale's Lode. Discovered about 1881 by Brady, who worked it for a few months, and then abandoned it. Subsequently tested by Chapman and Gale, who won a few tons of coarse black tin.

Lode strikes N. 38° E. in hard acid granite. Opened to about 14 feet in depth by a trench 150 feet in length. Width of lode, 4 to 8 inches.

Broken Hill Lode.—Near left bank of Bark Hut Creek, near head on Battery Mountain, ¼ mile N.E., of Stannum Lode, Parish Wellington Vale, County Gough.

Discovered in 1910 by W. Tomison and J. Maguire. Strike N. 40° E; dip, N. 50° W. at 77°. Hanging wall well defined. Lodestone, chlorite and quartz, with coarse crystalline tinstone, the tinstone occurring mainly on the walls. Mica developed in parts of lode. Country moderately hard granite. Developments, 25 feet inclined shaft, with 20 feet driven south-westerly; two other shallow shafts along the south-western strike; 17 cwt. of tinstone obtained to April, 1910.

About a chain west of the above, a large mass of chlorite, quartz, and ironstone, with zincblende, and a little chalcopyrite occurs, known as the "Broken Hill Silver Lode." The oxidation of the chlorite has given rise to a ferruginous outcrop. Opened by shaft and tunnel during the Broken Hill silver boom; but no encouraging prospects obtained. A sample tested in the Departmental Laboratory yielded :—

3622/08 { Gold—a trace, under 2 dwt. per ton.
Silver—2 oz. 14 dwt. 10 grs. per ton.
No tin detected.

Brown's Lodes.- North-east extension of Stannum Lode, on east bank of Bark Hut Creek, Parish Wellington Vale, County Gough. Strike N. 30° E.; dip, N. 60 W. at 78°. Crops in bed of creek, and further exposed by ground sluicing. The lode cuts across a belt of aplite at an acute angle. In the latter numerous thin tin veins occur, as joint fillings, from $\frac{1}{16}$ to ¼ inch thick. These strike N. 15° E. The tinstone occurs sometimes with quartz; other times crystallised alone on the joint faces. Molybdenite occurs very sparingly.

This site has been fossicked intermittently for a number of years. A shoot or "bung" of tinstone was opened in the creek bank on the main lode strike; a shaft was sunk 20 feet, and 15 feet of stoping done. The shoot split up into a number of knife-edge seams with a little tin; 32 cwt. of tinstone were obtained in the first 7 feet of this shoot. The thin veins at the surface have been dollied for about 1 cwt. of tin, but are unworkable unless the mass will pay to treat as an open-cut "stockwork." A bulk trial would be the best test.

Byrne's Lode.—2 miles N.E. of Dutchman's Lode, Portion 3, Parish Annandale, County Clive. (Burn's Lode on David's Geological Map of Vegetable Creek.)

Discovered about 1875, the following record being published :—

> "On another lode, known as Byrne's Reef, very good tin has been found in hard quartz. Two trial shafts have been sunk to about 18 feet in depth, and since filled up. Further operations were abandoned on account of the large quantity of water struck in them. The surfacing around the shafts has been very rich."*

In 1877 it is recorded that the two shafts were each 40 feet deep, exposing the cap of a well-defined lode, striking N.E. between soft granite walls. The cap was several feet thick, with tinstone showing freely.†

In 1878 and 1879 the lode remained unworked. In 1880 it was acquired by the Great Britain Tin-mining Company, and exploratory work carried on.‡

After this date separate mention is not made of this lode in the Company's operations.

Captain Cook Lodes.—At head of Stacey's Gully, Battery Mountain, Parish Wellington Vale, County Gough. Three or more closely parallel lodes, opened by shallow pits and trenches for a considerable distance. Fossicked in 1909 by W. Thomison, particularly on lode from 3 to 18 inches wide; richest usually where thinnest. A peculiar epidotic-looking mineral associated with the tinstone, proved to be altered felspar. [7,466.]

These lodes appear from their position to correspond with *Davy's* lodes, described by David :—

> "In Portion 173, Parish of Wellington Vale, County Gough, are Davy's four veins in granite, within a distance of 5 chains, striking from 28° to 30° east of north and west of south, the width varying from 2 inches to 3 feet, the average being about 9 inches. Tinstone occurs in quartz and mica. The footwalls are fairly well defined; but there are no hanging walls, the lodestuff clinging firmly to the granite casing. The veins are crossed nearly at right angles by dykes of eurite."§

Castle Wellington Lode, Planet Flat, $\frac{1}{4}$ mile south of Stannum, Parish Wellington Vale, County Gough.

Operations commenced by the Castle Wellington Tin-mining Company (G. Fearby, manager) in 1890, and continued for about one year. Strike N. 40° E.; dip, N. 50° W. in porphyry, walls well defined. Three shafts sunk along lode. Main shaft sunk 90 feet vertically, then cross-cut 12 feet west to lode; sinking wet. The lode stuff carrying thin veins varies up to 7 feet in width, with coarse crystalline tinstone.

The Company installed a 12 h.p. engine, stonebreaker, Huntington mill, and two Frue vanners, for treating the lodestuff. During 1891 the mine was worked on tribute, 223 tons being treated at the battery, but the result is not recorded; evidently it was not encouraging enough to keep the mine going.

Cemetery Lode.—Between Stannum and the east branch of Bark Hut Creek, $4\frac{1}{2}$ chains N. 25° W. from north-east corner of Stannum Cemetery, Parish Wellington Vale, County Gough.

A thin persistent quartz vein striking N.E. from 1 to 4 inches thick. Opened at intervals for about 25 chains. Patches of rich tinstone worked down to 30 feet at most, in soft picking granite. Best returns obtained where felspar makes instead of quartz. Several tons of tin ore obtained by different parties at various times.

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* Ann. Rept. Dept. Mines, 1875, p. 107. † *Op. cit.*, 1877, p. 149. ‡ *Op. cit.*, 1880, p. 164.
§ Geol. Veg. Ck., 1887, pp. 135-136.

Chapman's Lode.—M.L. 275, near Lee's Gully, Battery Mountain, Parish Annandale, County Clive.

Discovered by Messrs. Chapman, Gale, and McDonald in 1884, and worked by them for three years, then abandoned for some time. Worked by Chapman and Ogilvie from about 1900 to the present. Strike N. 42° E. Dip slight to N. 48° W. Veinstone quartz, chlorite, and ironstone in hard acid granite; in some places, aplitic. The width varies from 1 ft. 6 in. to 5 ft. 6 in. An average of five parallel veins of tinstone occur in the lode. A little copper pyrites is present, especially in the quartz. Joints in the granite cross the lode at an acute angle; where the larger intersect, the lode practically wedges out.

Several shafts have been sunk along the strike of the lode for about 150 feet. The original 75-feet shaft was sunk by the Stannum Lode Company to the 110-feet level, a little tinstone showing in the bottom. Brown Bros. also sank 50 feet at the north end, but did not meet with sufficient encouragement to proceed with the test. From another shaft sunk 45 feet at this end 10 tons of tin ore are reported to have been extracted.

At the south end much chlorite is present; an opening here, 50 feet in length, yielded 3 tons of tin ore at the rate of 3 cwt. per ton.

In 1909 Messrs. Chapman and Ogilvie discovered a vein 1 to 2 inches thick, yielding rich specimens.

Cliff Lode.—See "The Cliff."

Cook's Lode.—M.L.'s 178, 181. Parish Wellington Vale, County Gough; 1 mile N.N.W. of Stannum, on Battery Mountain.

Discovered in 1876 by Frank Cook, and worked for the Planet Company at intervals for two years.

Strike N. 30° E. Dip N. 60° W. Narrow veins of quartz, chlorite, and ironstone in coarse acid granite, extending through a width of 6 feet. Opened for about 900 feet by shallow trenching and several shafts. Most of the tinstone obtained has been won from a shaft 44 feet deep at the north-east end of the trenching, where a solid 4-inch vein of tinstone in quartz was worked by Thomison and others, 21 tons being obtained by them, in addition to several tons by numerous fossickers.

The Planet Company sank a 60-feet shaft near the spot, and obtained 2 tons. The granite country was decomposed to a depth of 20 feet. Most of the quartz in the lode exhibits comby structure. A rich parallel leader of a few inches in thickness was worked a few feet east of the main line.

Couch's Lode.—200 yards south of Castle Wellington Tin Mine, quarter of a mile south of Stannum. Parish Wellington Vale, County Gough.

Discovered by R. Couch about 1895, and worked by him for about a year. Strike about E. and W. in porphyry. Opened by two shafts and shallow trenching for about 150 feet along the strike. Rich patches of tinstone occurred near surface. Several tons of tin ore obtained.

Davy's Lodes.—See "Captain Cook Lodes."

De Braun and Richardson's Mine.—An extension of Ward and Atkinson's Lode, on east side of Battery Mountain; 1 mile N.N.W. of Stannum, Parish Wellington Vale, County Gough.

Situated 4 chains N.E. of Ward and Atkinson's Shaft.

Strike N. 42° E.; dip N. 48 W. at 65° in acid granite.

Opened to 25 feet on underlay, and driven a short distance on S.W. strike. Walls well defined, with cross jointing on footwall. Veinstone, quartz and chlorite with tinstone. About 4 tons of tin ore obtained to April, 1910.

Elliott's Lode.—Portion 1A, Parish Annandale, County Clive ; and Portion 149, Parish Highland Home, County Gough.

In 1877 G. A. Gower reported :—

> "Messrs. Elliott and party applied for 20 acres of land under mineral lease, on which very promising indications of a lode existed. So far no great depth has been reached by the men employed, but the work done gives them confidence that a payable lode will be discovered. Very good prospects are obtained from the stone about 12 feet from the surface, the lode having gradually widened out to 2 feet at that depth. An open cutting about 6 feet long discloses the run of the lode, which is about north-east and south-west. The quartz thrown out from here also has tin well through the stone. The granite on either side is rather hard, but shows very fair walls."*

In 1882 it was recorded by W. E. Henry, that three distinct lodes run through the 60 acres held by the party ; a seam of almost pure tinstone, showing in several places, having a thickness of 6 inches.†

In 1883 C. S. Wilkinson reported that—

> "A considerable amount of prospecting has been done on these lodes [Elliott's, and Speare and Moore's.—J.E.C.], and the results show that the tin ore occurs in shoots or bunches, sometimes as nearly solid ore, at others disseminated in crystalline grains through the veinstuff. The joint fissures which the lodes usually follow may extend to great depths, but the shoots of ore in them are of most irregular and uncertain occurrence, so that the proximity or otherwise of ore masses can only be ascertained by following the veins or joint fissures." ‡

In 1884, a lease having been obtained, a considerable amount of work was carried out.

David in 1887 recorded that—

> "Elliott's vein in Speare's Portion 1A, Parish Annandale, and 149 Parish Highland Home, a continuation of the preceding vein [the Geyser, J.E.C.] strikes 35° north of east and south of west, is nearly vertical, and averages 9 inches in width. Six tons of ore have been won from this vein, which averages 1½ cwt. of tinstone per cubic yard of veinstone."§

Elliott's, Grill's, and Romer's Leases, Torrington.—M.Ls. 17, 88, and 89, Parish Rock Vale, County Clive.

In 1906 the Elliott Tin Mining and Sluicing Company, N.L. (J. Mackay, Legal Manager, 125 Queen-street, Melbourne) was formed to acquire an area of 110 acres embracing Elliott's, Grill's, and Romer's leases at Torrington, the capital being 30,000 shares at 10s. each.

The following notes were extracted from the Company's reports.

Report for period from inception (6th November, 1906) to 30th April, 1907.

Five-head stamper battery—capable of extension to ten head—purchased, erection proceeded with.

Elliott's Lease, No. 1 Shaft.—Cut down, repaired, and continued to 52 ft. A rich shoot of ore followed from where Elliott left off at 22 ft. down to 40 ft., when it dipped south out of shaft. At 50 ft. a level was driven south 30 ft., and a rise put up 20 ft., which intersected the rich shoot passing out of shaft at 40 ft.

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* Ann. Rept. Dept. Mines for 1877, p. 149. † *Op. cit.*, 1882, p. 89. ‡ Ann. Rept. Dept. Mines for 1883, p. 150. § Geol. Veg. Ck., 1887, p. 130.

No. 2 Shaft continued to 55 ft., levels driven north and south at 50 ft. on formation 3 ft. wide, showing a little tin. Rise put up from South level where a little tin was showing.

Romer's Lease.—Two shafts bailed out and examined; formation carrying tin found in one, but small. In the other shaft the lode was 6 ft. wide.

Grill's Lease.—Battery and dam constructed on this lease. Several shafts in this lease yielded tin ore so far as worked, to water level, during earlier operations. One being reopened by the Company afforded good prospects.

Report for period ending 31st October, 1907.

260 tons of lodestuff crushed for 6 tons 11 cwt. 2 qrs. 11 lb. of tin concentrates, assaying 68 per cent., equivalent to 2½ per cent. of tin oxide in the lodestuff.

The Company subsequently purchased a wolfram property about 1 mile south; operations being eventually suspended in March, 1908.

Parallel lodes (unopened) occur about 100 ft. west of No. 2 lode.

Elliott's Lease Lode strikes apparently N.E. in aplitic granite. Discovered by R. W. Elliott about 1906, (owing to shallow alluvial ground at the site carrying tin ore), who sank 19 ft. in the lode and obtained 2 tons 4 cwt. of dressed tin ore from a shoot 5 ft. long at the intersection of a cross lode. He then sold to the above company, who erected a 5-head stamp battery near by on Cow Flat Creek, and deepened shafts as described above. Operations were then abandoned. Elliott is now engaged in further development.

Folkestone Lode, Stannum, Portion 82, Parish Wellington Vale, County Gough. Opened about 1881–2. In 1882 it was reported that the shaft was down 112 ft. on the lode, which had a width of about 4 ft. The deepest level was at 30 ft. from surface. Worked by means of a whip; water heavy.* In the following year no work was done after May; the shaft was then 118 ft.

In 1883 C. S. Wilkinson, reported :—

> "The Folkestone lode is in granite, and runs east and west. It is from 8 to 18 inches thick, consisting of quartz with zinc blende, galena, arsenical and iron pyrites, and tin ore. A shaft has been sunk upon it to a depth of 100 ft.† "

David in 1887 reported that sinking had been discontinued, as the vein did not become richer in tinstone, and expressed an opinion that the 'probability is that, if the sinking were continued through the metamorphic diorite on to the granite, the iron and zinc sulphurets would be gradually replaced by tinstone."‡

It is reported that a block of solid tinstone, weighing 7 cwt., was obtained from this lode. The shaft is believed to have eventually been deepened to 42 ft., where tin ore still occurs sparingly in mispickel.

Gale's Lode, 1½ chains N.W. of N.E. corner of M.L. 197, Parish Wellington Vale, County Gough; ¾ mile N.N.W. of Stannum. Discovered in 1896 by W. Gale, and worked intermittently since. Strike N. 30° E. Dip N. 60° W. to 87° in coarse acid granite, with aplite adjoining the lode. Hanging wall well defined. Seven thin veins occur in a width of 2 to 8 feet. Near the S.W. end of workings a shaft was sunk 60 ft; at the bottom 4 ft. of lodestuff is reported to carry tinstone very sparingly.

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* Ann. Rept. Dept. Mines for 1882, p. 89. † *Op. cit.* 1883, p. 150. ‡ Geol. Veg. Ck., 1887, p. 143.

A level has been driven for 110 feet along the strike of the lode from the east bank of Brady's Gully; and an open cut for 30 ft., at about 30 ft. above the drive.

In all, about 14 tons of fine black tin ore are reported to have been won from this lode, the lode stuff being treated in the Torrington Battery.

In 1909, a small crushing machine—the "J. W. Johns Patent Breaker"—worked by a small oil engine, was installed by Messrs. Lyons and others; it however, proved unsatisfactory.

Geyser Lode.—In 1882 it was reported that this lode had been opened by shaft to 32 feet, by the Torrington Company, and driven 16 feet.*

Probably "Gasser's" Lode mentioned by C. S. Wilkinson† is identical with the above, as it is located about 20 chains south-west from the Torrington mine. At this date it was described as striking north-east, nearly vertical, and from 3 inches to 1 foot wide, and as opened for 200 feet along its course, and for 42 feet in depth.†

At the end of 1883 the Mining Registrar reported that at the "Keyser" three shafts had been sunk, two to 50 feet, and one to 60 feet, and a considerable amount of stoping done.‡

About the same year the mine was examined by David, who describes later as occurring—

> "In portion 500, Parish Annandale, County Clive. Strikes 37° north of east and south of west, and is almost vertical, averaging 11 inches wide. The tin ore occurs in a thin solid seam next to the hanging wall, having for a footwall a dyke of eurite 1 foot wide; it also runs into shoots through the eurite. The deepest shaft is 74 feet, the vein at the bottom being one foot wide; but as the shoots became exhausted at this depth further sinking was discontinued."§

Lee's Gully Lodes, Battery Mountain, Parish Annandale, County Clive.—The first mention of these lodes occurs in 1882, the Great Britain Company having sunk four shafts at Little Catarrh Creek, Lee's Gully, to depths of 2, 10, and 12 feet, in very hard rock; the stone raised from them being fair to good.

Messrs. J. E. Elliott & Co. also had a block at Lee's Gully, 20 acres out of 60 being prospected, and proved very good. On one part there was excellent surfacing, whilst three distinct reefs ran through the 60 acres, showing well on the surface. In one place, a seam of almost pure tinstone, averaging 6 inches in thickness, occurred for several yards.‖

In the following year the Great Britain Company abandoned prospecting operations, and Elliott and party did no work.

In 1884 Elliott and party obtained their lease, and carried out a considerable amount of work on it. Langton and party and Murray and party were also engaged prospecting lodes at Lee's Gully.

David records seven distinct veins in the Lee's Gully set, and four in Portion 483, Parish Annandale, County Clive:—

> "The westernmost strikes 34° east of north and west of south, dipping north-westerly. The vein is altogether 4 feet wide, of which from 6 to 8 inches are tin-bearing. The footwall is defined, but what is considered to be the hanging-wall seems to be a joint in the granite, showing fair traces of slickensides. The barren veinstone is a hard quartzose felstone

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* Ann. Rept. Dept. Mines for 1882, p. 89. † *Op. cit.*, 1883, p. 150. ‡ *Op. cit.*, p. 104.
§ Geol. Veg. Ck. 1887, pp. 129–130. ‖ Ann. Rept. Dept. Mines for 1882, p. 89.

containing a little mica; the tin-bearing portion of the vein is composed of ferruginous quartz and chlorite. The tin occurs disseminated in small black crystals, or massive in nests or strings.

"Thirty-four yards easterly is a vein similar to the preceding, striking 38° east of north and west of south.

"Twenty-eight yards further east is a similar vein, striking 40° east of north and west of south, dipping 70° north-westerly, and containing, in addition to tin-stone, wolfram and hæmatite. The tinstone runs in three seams, through chlorite.

"Forty yards further east is another similar vein, striking 43° east of north and west of south, dipping north-westerly. The walls are fairly well defined, and show slickensides. It would appear from the strike of these veins that they should converge near the south-west corner of portion 483.

"Near the north-west corner of portion 545, in the same parish, are two contiguous veins, not shown on the geological map, striking 20° east of north and west of south, dipping about 86° north-westerly. The principal vein, in places, is from 4 to 5 feet wide, containing fine black tinstone; this is perhaps the champion vein.

"Near the south-east corner of portion 259, thin tin-bearing quartz veins strike 38° east of north and west of south, dipping 86° north-westerly. The country, as before, is a hard fine-grained quartzose granite, almost a felstone. One of these veins has been traced for over 14 chains, and is from 3 to 6 inches in width, carrying a seam of solid tinstone $\frac{1}{2}$ inch to 1 inch wide.

"In portion 275, in the same parish, the north vein shown on the plan strikes 40° north of east and south of west, composed of quartz and chlorite, and from 5 to 6 feet wide.

The vein south of the preceding, in the same portion, strikes about 26° east of north and west of south. A shaft has been sunk on this vein over 100 ft. deep. The veinstone, which is similar to the preceding, is said to be from 3 to 4 ft. wide in the shaft. The tin is fine and black, occurring in thin seams intersecting the quartz. The veinstone is decidedly poor in ore." *

Three parallel lodes in Lee's Gully—doubtless identical with some of those described above, were worked under the name of "Great Britain" lodes; two shafts being sunk, each 50 feet. Veinstone very siliceous and chloritic. A little tinstone in bottom of shaft. About 20 tons of tin ore obtained.

Lane and Herbert's Lode, one mile west of Stannum, on south spur from Battery Mountain, Parish Wellington Vale, County Gough. Strike, north-east; dip, west, at 70°. Opened by shallow trenching and shafts for about 300 ft. along the strike. Worked intermittently for many years, and recently by Messrs. Lane and Herbert, who sank 30 ft. from crest of hill, obtaining about 15 cwt. of tinstone from last crushing. Veinstone consists of quartz, mica, chlorite, and ironstone. The tinstone occurs in thin seams, and is crystallised. Average width of lode, about 1 ft.

McDowell's Contact Lode.†—M.C.P. 211 and M.Ls. 2, 10, Parish Silent Grove, County Clive. Discovered by McDowell and party, in 1899, in M.C.P. 15, at junction of granite and slate. Strike, approximately north 75° east. Opened by numerous shafts to about 70 ft. at deepest, and by shallow trenches and open cuts for a length of about 400 feet, and connected by levels for about 350 feet.

* Geol. Veg. Ck., pp. 133–134. † See also Silent Grove Lodes.

Sinking is through slate on to aplite, in which the lode occurs. The granite country is of the acid type, and porphyritic by large felspar crystals. The lode rock is almost quartzose for the most part; in places mica gives a greisen aspect. Pegmatite veins also occur.

The lode, in addition to tinstone, contains bismuth (oxide and carbonate), zinc-blende, galena, pyromorphite, and chalcopyrite.

Mining continued until September, 1907. During this period 203 tons of tin ore, assaying 72·5 per cent., were obtained from the lode. Forty tons were also obtained by Messrs. McGillivray and Wilson, and a number of tons of shed or alluvial tin from the soil surrounding the lode; total, about 240 tons.

The lode is reported to have varied from 4 to 15 feet in width, averaging 10 feet.

A parcel of concentrates from the mixed ores treated at Cockle Creek in 1907 yielded the following results :—

Silver	77 oz. per ton.
Gold	a trace.
Lead	67 per cent.
Tin	20 ,,

In 1909 the Australasian Exploration and Development Company, Limited (Adelaide), secured an option, and proceeded to test the lode by cleaning out the main shaft and sinking a new one 300 feet south 80 east from the former, in untried ground. At 109 feet, aplitic granite was reached under the slate, apparently a little off the line of lode, which at a deeper level is to be cross-cut for. A few plates of molybdenite occur in the aplite.

Some rich patches of tinstone are still visible underfoot in the old workings from the main shaft. The richness of the shoots in this lode is evidenced by 90 tons treated at Silent Grove battery in 1903, yielding 51½ tons of tin ore, assaying 72½ per cent. metallic.

Mica Lode (Smith's).—M.L. 65, Parish Rock Vale, County Clive, Black Swamp Creek. Shaft sunk in biotite, near junction of sedimentary rocks and aplite. Tin occurs in small quantity associated with wolfram, beryl, and a few plates of a green mineral resembling torbernite (copper uranite).*

Mountain Maid Lode, about half a mile north-east of Stannum Lode, and 100 yards east of Boomerang Lode. Battery Mountain, 1¼ miles west of Stannum, Parish Wellington Vale, County Gough. Discovered by W. Lefrancke about 1893, and worked for about a year. Strike north-east, dip north-west at 60°, in coarse acid granite. Tinstone occurs in bunches (locally called "bungs") along the strike. Decomposition of the lode has given rise to a deep crevice in the granite on the summit of the range overlooking Bark Hut Creek. Several tons of tinstone have been won from it.

Mount Pleasant Lode.—Portion 122, Parish Rockvale, County Clive. David described this lode as—

> "Striking 26° east of north and west of south, dipping at 83° in a north-westerly direction. The width varies from ½ foot to 2 ft. 6 in., the average being 1 foot. The lode-stuff is a friable, porous quartz and chlorite. The structure of the vein-stuff suggests that the fissure, after being filled with chlorite and quartz, was partially reopened, the new cracks being lined with white silica and tinstone. This vein much resembles Butler's."†

* A tin lode in M.L. 79 adjoining on the east, has been opened by several shafts for about 1 chain along the outcrop, soft picking ground : 4 tons tin ore reported to have been obtained.

† Geol. Veg. Ck., 1887, p. 127.

Planet Tin Lode.—Portion 119, Parish Wellington Vale, County Gough. Near the village of Stannum, to the south-west.

The Planet was the first tin lode opened in the State, though small tin veins had been noted in the bedrock at Elsmore at an earlier date. It was applied for by James Piercy and W. Collins in 1872, and surveyed on 23rd November of the same year.

In 1875 it was noted that "the tin lodes have not yet had much attention directed to, or capital invested in them, and even when a fair prospect of testing the lodes with advantage presents itself, the owners of the land ask such exorbitant prices as to deter capitalists from investing. . . ."

"The only property taken up for the purpose of working lode tin, and on which a quantity of work has been done by an English company, under the management of Captain Stevens, is situated at the Nine-mile, Mole Tableland. A battery of eight stampers is being erected on this mine; there are 1,000 tons of quartz at grass ready to be operated on."*

G. H. Gower, in his report for 1875, stated that "only very feeble attempts have been made to test the lodes. The greatest depth to which any shaft has been sunk did not exceed, it is said, 120 feet. At the Planet Tin Mining Company, Nine-mile Creek, Mole Tableland, a considerable amount of labour and capital were expended in this branch of mining by the company, but no permanent benefit was derived therefrom, for the veins either soon ran out, or the stone below a certain depth became unprofitable.

"It is to be regretted that the shafts have not been sunk deeper, and stronger efforts made to investigate the character of the lodes at a greater depth. This company have the credit of erecting and working the first crushing and lode tin-dressing machinery in this colony. The battery is furnished with all the latest improvements, carrying eight head of stampers. There was a large quantity of tin-stone at grass, but I have been led to believe that, after a trial crushing, but very little of it was found to be payable. Operations at present, I understand, are confined to breaking out leaders or veins, very rich in tin, averaging a width of half an inch, which were exposed in the surface rocks; but up to the present time the yield of this mine has not been very satisfactory."†

Several shafts were sunk for a distance of 450 feet along this lode, which strikes north 78° west in porphyry, the deepest about 150 feet. Arsenical pyrites was prominent at a depth; a little wolfram was also present.

In Portion 122, close by, is a similar lode to the Planet, described by David as—

> "Striking east 10° north, and having a width of from 7 to 8 feet. This vein has not yet been prospected. The metamorphic rocks enclosing these veins are rich in iron sulphides."‡

Another adjacent lode was opened by R. T. Crouch in 1890, on the flat near 9-mile Creek, to a depth of 50 feet, following an ore-shoot 10 to 12 feet long and 14 inches wide, becoming wider at bottom but split into veins across the width of shaft, passing below into pyritic ore carrying about 3½ per cent. of tinstone; 13 tons of rich tin ore were extracted.

Reid and Crane's, in Portion 700, Parish Wellington Vale, County Gough, is marked on the original geological map of Vegetable Creek, as "Bark Hut Lode."—

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* Mines and Mineral Statistics N. S. Wales, 1875, p. 66. † Ann. Rept. Dept. Mines for 1875, p. 107.
‡ Geol. Veg. Ck., 1887, p. 144.

"Strikes 37° 30′ east of north and west of south, dipping north-west. The vein has been proved for a distance of over a ¼ of a mile, two shafts having been sunk on it to depths of 50 and 55 feet respectively. The vein varies from 8 inches to 3½ feet in width. The walls are not always well defined, as they come together in places so as to form a single central crack, the sides of which are infiltrated with vein material. The vein-stuff is ferruginous quartz and chlorite, and fluorspar. The last occurs in seams 1 inch wide, traversing the chlorite. The tinstone is present in well-formed crystals in the quartz and chlorite, favouring the foot and hanging walls, and occasionally the centre of the vein. The granite enclosing the vein is not very hard, and consists of blebs of quartz, ⅓ inch in diameter, in a more finely crystalline base of large and small crystals of felspar and dark mica. The joints trend 32° west of south and east of north. This vein is probably a continuation of the Fergusson and Wallaroo, the strike having changed with that of the jointing in the granite. Fifty tons of ore from this vein are said to have averaged 3 cwt. of tinstone per ton, equal to 13 per cent."*

A shaft was sunk in 1882 to 40 feet, and deepened to 60 feet in 1883 ; 40 tons of ore being carted to Tent Hill Battery.†

Silent Grove Lode.—M.C.P. 210, of 80 acres, Parish Silent Grove, County Clive. Reported to have been discovered by Messrs. Curtin (shepherds on Mole Station) in 1873, worked by them for a few months ; then taken up by Wilson Bros.

In 1877, G. H. Gower reported that Messrs. Stewart and Watt, of Sydney, were the owners of 140 acres of lode-tin land at Silent Grove, situated about 14 miles northerly of Mole Tableland, and 32 miles north west of Vegetable Creek."

"At present a shaft is being sunk, and at a depth of 30 feet the lode appears to be about 2 feet wide, a seam of tin about 2 inches thick being in the centre, the quartz at the sides having good tin all through it. The proprietors have bought a crushing machine with ten head of stamps, replete with all the latest improvements for extracting the ore from the stone, which is now in course of erection." . . .

"There are three tin-bearing lodes in this land, which are situated about a mile distant from each other, are parallel, and run about north-east and south-west."‡

During 1878, sinking was actively carried on. In 1879, prospects were not so encouraging. In this year bismuth was discovered at Silent Grove.§ No progress is recorded in 1879, 1880, or 1881. In 1882 W. S. Henry reported under the head of Silent Grove :—

"There is not much going on here at present, though once the scene of considerable activity. Messrs. R. Towns & Co., own a valuable mining plant which became idle when tin fell in price a few years back ; but there are three men employed ground sluicing with satisfactory results."‖

In 1883 two men were employed sinking in the lode. In this year C. S. Wilkinson visited Silent Grove Tin and Bismuth Mines, which he described as follows :—

"The principal tin lode has been traced about 250 yards north-east and south-west, traversing porphyritic granite. It consists of ferruginous

* Geol. Veg. Ck., 1887, p. 133. † Ann. Rept. Dept. Mines for 1882, p. 89, and 1883, p. 104. ‡ *Ibid*, 1877, p. 149. § *Ibid*, 1879, p. 155. ‖ *Ibid*, 1882, p. 90.

quartz, containing tin, chlorite, and white mica, and is from 4 inches to 6 feet thick. About 1 mile W. 15° N. from this a quartz and felspar vein from 4 to 9 inches thick, strike W. 15° N., contains, besides tin ore, metallic bismuth, sulphide and oxide of bismuth, chlorite, and white mica. Bismuth was first reported in 1879.* Close by is a belt of quartzite, 40 feet wide, striking S. 30° W., having altered slate on the east side and euritic granite on the west; quartz and granitic veins with tin ore traverse this quartzite. Some surfacing has been done here for stream-tin, which has been derived from these veins; and in the surfacing, a quarter of a mile to the west, lumps of tin ore 2 lb. in weight are said to have been found. On portion 71 in the same parish—Silent Grove—there are two other quartz and felspar lodes containing tin ore. All the lodes of this locality occur near the junction of the granite with the slate."*

The reference to the western lode agrees with the lode described as McDowall's, the latter being traced into McGillivray's property on the east.

In 1887, W. H. J. Slee reported that a good deal of work had been done on the Silent Grove lodes by the Glen Smelting Company, but so far with not very encouraging results.†

In this year David published his notes from observations made in 1884:—

"The Silent Grove veins are five in number. In portion 15, parish of Silent Grove, county Clive, are two nearly parallel veins; the north vein strikes 15° south of east and north of west, dipping northerly. Width, 13 inches; vein-stuff, quartz, felspar, chlorite, and mica, with tinstone and bismuth. The tin lies next to the hanging-wall for a thickness of 9 inches; the remaining 4 inches of vein-stuff contains bismuth; the latter occurs native, and as sulphide, in acicular crystals radiating through the quartz, and near the surface as an earthy oxide. At 25 feet from the surface the bismuth became entirely replaced by tinstone; the strike of this vein coincides with that of Burns' bismuth vein 10¾ miles south-south-east.

"One chain south of the preceding, a vein strikes 20° south of east and north of west. The vein-stuff, including the granite infiltrated with vein material, is at least 6 feet wide, and consists of tin-bearing rotten felspar, 1 foot wide, passing into a quartzose felstone containing chlorite. The vein has no defined walls. The ores are tinstone and arsenical pyrites. The former runs in shoots through the vein-stuff from 8 inches to 10 inches wide, pitching about 30° in an easterly direction. The country is a fine-grained quartzose felstone, containing chlorite.

"The vein which has been most prospected here strikes through portions 12 and 13 in the same parish. South of the main shaft, 75 feet deep, in portion 13, the vein strikes 31° east of north and west of south for a distance of 4½ chains while north of the same point it bears 28° east of north and west of south for a distance of 8 chains, dipping south-east.‡

"The veinstone is chiefly cellular quartz, mica, and chlorite, with tin-stone, magnetite, and manganese. In places the quartz is coloured pink by a silicate of manganese resembling rhodonite.

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* Ann. Rept. Dept. Mines for 1883, pp. 150, 151. † *Ibid*, 1887, p. 113. ‡ The Main Silent Grove Lode.—J.E.C.

"The tin-stone occurs in bunches of solid ore, 3 inches wide in places. The casing is hard quartzose granite. Ten tons of ore were crushed from this vein.

"Three-quarters of a mile south-east of the preceding, in portion 71, in the same parish, are two parallel running veins. The west vein strikes 30° east of north and west of south, dipping north-westerly; it is from 1 to 2 feet wide, and contains tin-stone in friable quartz. A shaft has been sunk on it to a depth of 40 feet.

"Twelve yards south-east of the preceding is a second vein, from 1 to 4 feet wide, striking 30° east of north and west of south, underlying north-westerly. The tin-stone occurs in felspar and cellular quartz, either in bunches or in small crystals disseminated through the mass of the veinstone. A shaft has been sunk on the vein, 50 feet deep. Fourteen tons of ore have been won from the last two veins."*

Messrs. McGillivray and Wilson obtained possession of the Silent Grove property of 160 acres, in 1901, since when 100 tons of tin ore have been won. Of this amount 75 tons came from M.C.P. 211 and the balance from M.C.P. 210.

In all, about twelve shafts have been sunk, averaging 50 feet in depth, in a distance of about 900 feet; the main shaft, near the centre of the workings, being 290 feet deep on the incline, or about 150 feet vertical. A fair amount of driving has been done from this and other shafts.

The lode at the bottom of the main shaft is reported to be 4 feet wide. The ore occurs in shoots, with barren crystallised quartz between. The tin-stone is associated with magnetic iron, ilmenite, hematite, manganese oxide, and considerable zinc-blende.

Inspector Carthew reported in 1901 that a fair amount of ore was being obtained under the management of Mr. McGillivray; and a five-head battery with Wilfley tables and Cornish buddles, was employed in crushing and dressing.†

During 1905, 30 tons of tin ore were reported as the output, and 56 from McDowell's mine.‡

In 1907 ore to the value of £650 was raised,§ but the mine was idle during 1908.

It was reported that the influx of water, and the complex nature of the ore, hampered operations.‖

A sample of siliceous lode-stuff selected by the Writer from the waste-heap, yielded an assay :—

2317-10	Silver, 6 oz. 1 dwt. 23 qrs. per ton. Gold, a trace. Zinc, 3·22 per cent.

Stannum King Mine, M.Ls. 110, 191 (formerly "The Coppers").—Parish Romney, County Clive, about 8½ miles from Deepwater, on east bank of Deepwater River.

Tin lode traversing granite. Strike N. 10 E.; dip S. 80 E. at 72 degrees. Veinstone quartz, with small bunches of tinstone. Outcrop traceable for about 11 chains from portion 97 to Hamilton's Gully. Opened by two shafts 8 feet apart, to depths of 38 and 55 feet, trenched for 15 feet, and exposed in shallow openings northerly to near the south-east corner of portion 30.

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* Geol. Veg. Ck., 1887, pp. 119, 120. † Ann. Rep. Dept. Mines for 1901, p. 85. ‡ *Ibid.*, 1905, p. 48, § *Ibid.*, 1907, p. 58. ‖ Plant now consists of 10 head stamp mill, hydraulic separator, buddles, kieves, &c.; 25-h.p. boiler; two 20-h.p. engines, steam pumps, classifying and concentrating plants. &c.

This reef was discovered about 1875, when the 55-foot shaft was sunk. The second shaft was sunk by the present owners, the vein at the greatest depth in it being reported as 7 inches wide, but thinned to about 2 inches. The country is hard granite. Seams of chlorite occur, as well as copper carbonate stains, and thin seams of chalcopyrite. It is reported that the several "shoots" have yielded a few tons of ore.

Stannum Lode Tin Mining Company (*N.L.*), J. Mackay, Legal Manager, 125 Queen-street, Melbourne. Operating a tin lode in M.L. 32, Parish Wellington Vale, County Gough, locally known as "Bark Hut Lode," but not the lode of that name shown on David's map of Vegetable Creek district, occurring in Portion 700, and described under the name of Reid and Crane's lode.*

The Stannum lode outcrops on the west bank of the east branch of Bark Hut Creek, about 60 chains east of the original Bark Hut lode.

It strikes N. 30° E., and dips N. 60° W. at 78°; and occurs as a narrow joint plane in hard aplitic granite. In places tinstone forms a mere streak along the joint, in others gives out entirely. One rich shoot, or pipe-like ore-body, of a width of 3 feet, was worked by E. Worrall before the present company obtained possession. About 30 tons of dressed tinstone are reported to have been extracted by him from it. The tin oxide occurs in fine crystals, associated with pearly felspar. Carbonate of iron is a constant lode constituent, whilst fluorspar and molybdenite are rarely present.

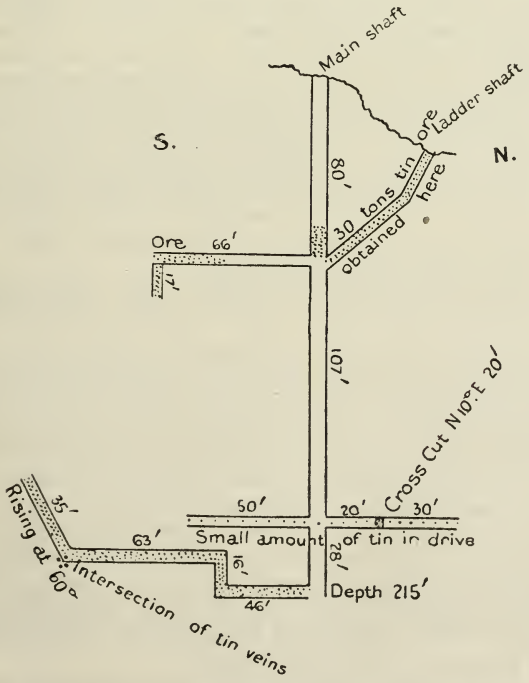

Fig. 7.—Section of Workings, Stannum Lode, showing lowest developments to October, 1909.

* Geol. Veg. Ck., 1887, p. 133.

The progress of development since the formation of the company is outlined in the following extracts from the half-yearly reports :—

"During the first period—from inception on 7th November, 1906, to 20th April, 1907—an option was obtained over Ogilvie's adjoining lease, the shaft in it cut down 74½ feet, and a contract let to deepen it to 117½ feet. The work exposed insufficient tin-ore to warrant purchase of lease. On the company's ground the Whip shaft was repaired and deepened to 100 feet. Drives put in north 63 feet, and south 79 feet. Cross-cut west begun with a view of cutting Old Cliff line of lode.

"In *Judge's Mine*, tunnel enlarged to allow of tramway. Shaft deepened to 89 feet. Lode formation met in shaft; good indications at one end. From *Worrall's section* 5 tons of 40 per cent. ore obtained.

"During the period ending 31st October, 1907, the Whip shaft cross-cut was extended 45 feet from shaft, but failed to cut the Cliff line; operations were therefore suspended, as the latter was believed to have pinched out. The main shaft in Judge's mine was continued to 110 feet, and driven north 55 feet to old winze, where eight bags of 50 per cent. ore was obtained, which exhausted the visible supply. From bottom of winze drove north 45 feet—result improving; work suspended.

"*Worrall's Mine.*—New shaft sunk 83 feet to connect with Worrall's old workings. Payable ore struck before reaching the latter. Ore-shoot pitching south, followed for 45 feet from new shaft, size 4 ft. x 2 ft., 15 tons of ore obtained from it.

"During the half-year 35 tons of lode-stuff were crushed for 19 tons of concentrates assaying 75 per cent.

"During the period ending 30th April, 1908, work was confined to Worrall's shaft. The rich shoot of ore being followed in the winze for a further distance of 50 feet, or a depth of 150 feet from surface. Its size being 8 feet by 2 feet.; in sinking 66 tons of ore were extracted, which yielded 37 tons 17 cwt. of concentrates assaying 76 per cent. metallic tin.

"For the six months ending 31st October, 1908.—Contract let to sink main shaft from 87-foot level following dip of lode joint; 123-foot level reached. No. 1 winze driven south 66 feet from 80-foot level; No. 2 driven north 25 feet from 30-foot level.

"For half-year ending 31st October, 1909.—Main shaft, Worrall's section, deepened to 215 feet. No. 3 south drive at this level struck ore-shoot in a few feet, which continued for 45 feet from the shaft; the shoot then rose in the back 16 feet, then continued south for 63 feet. Here the shoot measured 4 feet by 3 feet, worth 15 per cent. tin ore, and continued to pitch southerly. At the furthest proving in this direction it was 42 feet further south than in the old workings overhead. At 98 feet from the shaft payable ore was rising in the back of the drive. From No. 1 north-east drive a cross-cut through hanging-wall cut continuation of lode formation which was exposed in No. 1 north drive. A drive 15 feet along the formation revealed a small percentage of tin ore.

"During the half-year 32 tons of ore were crushed at the Torrington battery for 12 tons 11 cwt. 1 qr. 11 lb. of concentrates. A 5-stamp battery, with Wilfley tables and Frue vanner, were purchased, and in course of erection towards close of 1909.

"The manager, Mr. H. Judge, reported under date 27th June, 1910, that the main shaft was down 265 feet in hard felsite, and a cross-cut was in progress."

DETAILED Output from Stannum Lode since 1907.

Yea	Ore crushed.		Tin concentrates obtained.				Assay value of concentrates in metallic tin.
	tons.	cwt.	Tons.	cwt.	qrs.	lb.	Per cent.
Prior to 1907	.....		30				.....
1907*	9		4	5			77·6
,, ...	10		4	17			66·0
,, ...	16		8	12			75·0
1908	30		17	5			76·0
,, ...	4	4	2	5			73·0
,, ...	32		18	7	3	14	75·5
,, ...	29		13	12	0	27	76·0
,, ...	13	16	6	8	1	9	75·0
1909	13		5	3			75·0
,, ...	19		7	8	1	11	75·0
,, ...							
,, ...							
1910	278		16	4	1	26	Balance of output for 1909–1910.—Ann. Rept. Dept. Mines for 1910.
,, ...	Operations suspended at close of 1910.						
,, ...							
,, ...							
Totals	454	0	96	8	1	3	

Starlight Lode, at head of east branch of Bark Hut Creek, Parish Wellington Vale, County Gough. Battery Mountain. Strike N. 35° E. Discovered and opened for some little distance by W. Thomison.

The Cliff Lode.—Portions 131, 132, Parish Annandale, County Clive, 1½ mile north-west of Stannum, on Battery Mountain. Opened by the Planet Tin Mining Company about 1876. Described by David in 1887 :—

> " The Cliff vein, probably a continuation of the preceding [in portion 275—J.E.C.], strikes through portions 288 and 289, in a direction 26° east of north and west of south dipping 85° north-westerly. . . . The vein has all the appearance of being a joint in the granite, in which the tin has become concentrated by some process of lateral secretion or infiltration."†

In 1895 it is recorded that The Cliff Tin Mining Company was working a ode, and that a number of other parties were at work on the same lode ; ccasional shoots of ore being discovered, which, however, cut out in a few lays.‡

The lode occurs in aplite, and the tinstone in parallel joints, the videst not more than 3 inches, others appearing as mere thread-like veins. he original discovery was made owing to the vertical face of one of these ointings forming a cliff, being coated with a thin scab of tinstone.

The lode has been opened for a length of about 7 chains. A five-head tamp battery was erected in Stacy's Gully, about 1 mile south of the mine ; he ore averaged 6 cwt. per ton from the veins. About 150 tons of ore are eported to have been extracted.

In 1909 aid was granted from the Prospecting Vote to sink a shaft on the ode, the previous work being by open cut along the strike on the cliff face ; 0 feet of sinking revealed no payable stone.§

* Previous output estimated at 30 tons. † Geol. Veg. Ck., 1887, pp. 134–135. ‡ Ann. Rept. Dept. Mines for 1895, p. 59. § In 1910 a tunnel was being driven to cut the lode 60 feet below the open cut.

Torrington Lode.—Portion 541, Parish Annandale, County Clive. Discovered in 1881. In 1882 it is recorded that :—

> "The Torrington Mine, which has of late created so much excitement owing to the richness of the lode, has not been getting out such good stone during the latter part of the year ; but it is very likely that the company will again strike the rich deposits for which they are steadily prospecting. A lot of stone is at grass, and also being raised, which will pay well. In order to treat it properly, the company are erecting a 5-stamper battery, which is expected to be in full work during 1883. The stone is being raised by means of the old-fashioned windlass, and has to be carted to the washing plant, a distance of about a quarter of a mile, where a good dam has been made, and a tin house, also a manager's residence has been built, and where the battery is being erected. They have two shafts down to a good depth, one being 75 feet deep ; in it the lode is 15 inches wide at the 27-foot level."*

In 1883 the battery was started, all the stone at grass—455 tons—being crushed for a return of 56 tons of tin concentrates ; equal to 12·3 per cent.

The principal shaft was deepened to 98 feet, but the prospects were reported as not very encouraging. Cross-cuts had been driven east 17 feet and west 18 feet, to test the ground.

At the 50-foot level the lode was driven on south for 60 feet, and stoped up within 10 feet of surface, the tin-bearing stone averaging 10 inches in thickness.

Forty yards north No. 2 shaft was sunk to 54 feet in the lode, following a shoot of ore about 6 feet long and 10 inches wide, carrying good tin. North and south the lode is not defined. Several northerly shafts put down from 12 to 20 feet, exhibited good ore in places but not permanent.†

In the same year the lode was examined by C. S. Wilkinson, who described it as striking E. 40° N. :—

> "The lode-stuff in one place was 2 feet wide, consisting of fine-grained felstone with tin ore in it, chiefly near the hanging-wall and in irregular patches. At its north-east end the lode is cut off by a cross-course of fine-grained euritic granite, which is part of a large mass running south-east. Here tin ore has been followed from the surface downwards as a shoot dipping W. 40° S. ; it was 1 foot wide, and the hanging wall well defined with clay dig. The country is coarse micaceous granite traversed by veins of fine-grained granite. On the south-west side another parallel vein, from 3 inches to 2 feet wide, has been opened and about 10 chains E. 30° N. from main shaft is a small vein, strike E. 30° N., containing tin."‡

During 1884 the battery was kept almost continuously at work for tributors from the Torrington and other lodes. Five parties of tributors being engaged in different parts of the company's property, three of them on payable stone. The best results being obtained by Stephens and party from lode-stuff 18 inches wide at 55 feet ; the next being Young and party from a 10-inch lode at 45 feet ; 61 tons of concentrates being obtained during the year.§

During 1885 the mine continued to be worked under tribute. The company increased the efficiency of the milling and concentrating plant by buddles and improved dressing appliances. The yield for the year being 4 tons of tin ore.

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* Ann. Rept. Dept. Mines for 1882, p. 89. † *Ibid*, 1883, p. 104. ‡ *Op. cit.*, p. 150. § *Op. cit.*, 1884, p.

The plant in 1886 consisted of 12 h.p. engine, 5-stamper battery, and four puddles, valued at £2,000. The main shaft had reached 116 feet, the deepest level being 100 feet; width of lode, 1 foot. The output for the year was 3 tons 13 cwt. Twenty-four hands employed.*

In 1887 W. H. J. Slee stated that a fair amount of tin ore was raised during the year, but its occurrence was patchy.†

David, in 1887, published the results of his observations in 1883-4 :—

"The north-west branch of the main Torrington vein in portion 541, in the parish of Annandale, strikes from 21° to 23° north of east and south of west, being a continuation of Speares' and the Geyser. At 92 yards along its strike from its south-west end, the vein joins the main Torrington vein. A shoot of ore has been worked out of this branch vein, commencing near the surface at the point of junction in a south-west direction for a horizontal distance of 120 feet, in which distance the shoot dipped 40 feet. The main vein from the point where the branch leaves it has been worked for 34 yards south-west and 66 yards north-east; the strike is 42° 30′ north of east and south of west, the dip being 74° south-east. At its north-east end the vein is shut off abruptly against a dyke mass of euritic granite, striking 5° west of north and east of south. A rich shoot was worked here from near the surface to a depth of 135 feet. The shoot pitched 40° east of north and west of south, at an angle of 45°, and was 2 feet wide where widest, averaging 10 inches. The hanging-wall was well-defined. In part of the workings an intrusive dyke of eurite formed the footwall of the vein. Close to where the cross-course of eurite intersects the vein a bunch of ore was got out of 64 cubic feet of vein-stuff, weighing 13 tons. At the north-east corner of portion 543, in the same parish, is a vein considered to be a continuation of the main vein heaved to the south-east by the cross-course. The strike is 36° north of east and south of west, the average width being 8 inches. The veinstone is felspar, with tin crystals. The country is very hard fine-grained micaceous granite. The total amount of ore won from the Geyser, Elliott's, and the Torrington veins, up to the end of 1884, was over 70 tons."

"In portion 541, in the same parish, 3 chains south-east of the main Torrington vein, is a nearly vertical vein 1½ feet wide, striking 37° north of east and south of west. The vein-stuff is quartz and felspar, passing at the sides into a quartzose felstone, which in its turn changes into granite. The tin is disseminated through the felspar and quartz. The shoot became nipped at the bottom of the shaft 61 feet deep. This vein has been traced 187 yards to the north-east, and south-west to Thomison's, of which it is a continuation. In portion 1A, in the same parish, Thomison's vein strikes 40° north of east and south of west, dipping 74° south-easterly. A shaft was sunk on the vein 25 feet deep. The vein averaged 1 foot wide, and was traversed by nearly horizontal "floors." The course of the vein coincides with that of the joints in the granite, and the vein resembles, though on a larger scale, the one shown in Fig. 10. The ore is richest at the centre of the crack or joint in the granite, which the vein appears to have followed, the granite on each side of the joint having the appearance of having been permeated by the ore for a distance of several inches. Six tons of vein-stuff from here yielded, when crushed, 2 tons 8 cwt. of tinstone—40 per cent. of ore."‡

* Ann. Rept. Dept. Mines for 1886, p. 89. † *Ibid.* 1887, p. 113. ‡ Geol. Veg. Ck., 1887, pp. 130, 131.

Ward and Atkinson's Lode.—Battery Mountain, 1 mile N.N.W. of Stannum, Parish Wellington Vale, County Gough. Discovered by W. Thomison about 1897. Sunk on by Atkinson and Ward during 1909–10 to 25 feet on underlay. Strike N. 42° E.; dip. N. 48° W. at 65°; in coarse, acid granite; walls well defined. Veinstone, quartz and chlorite with tin-stone. About half a ton of concentrates obtained.

Whim Shaft Lode.—M.L. 196, Parish Wellington Vale, County Gough, 1½ miles north-westerly of Stannum, on Battery Mountain.

Opened by the Planet Tin Company about 1876, and worked for about a year. Strike N.E.; dip. N.W. in aplitic granite; average width, 3 feet. Shaft sunk 150 feet. Driven at 100 feet.

Re-opened by the Stannum Lode Tin Company in 1909 at the 100-foot level. A trial crushing of 18 tons extracted yielded less than 1 per cent. of tin oxide. At 150 feet a vein 10 inches wide is resported to exist.

(c)—Tingha–Inverell.

Alluvial.

Ah Bing's Lead.—Commencing near the south boundary of P.M.L. 84, Parish Swinton, County Hardinge, and extending south-easterly for about 25 chains. The south-east end revealed the following descending section :—

10 feet decomposed basalt.
3 feet fine sandy drift—no tin.
3 feet fine water-worn wash with water-worn tin ore.
Soft granite bedrock.

At the north-west end the wash was exposed at the surface. Worked from about 1880. About 200 tons of tin ore are reported to have been obtained from this lead, and it still affords a living for fossickers. Sinking is fairly dry until the rotten granite bedrock is entered. The average width is about 7 chains.

Ah Jack's Gully, forming the right-hand branch of Herding Yard Gully, and heading near south boundary of Portion 189, Parish Swinton, County Hardinge. Recent alluvium. Worked about 1875 by the Cope–Harding Company, who laid down a tramway to Herding Yard Gully to convey the wash to water. The width of channel averages about 40 feet, and the sinking 16 feet through yellow sand and a little clay, comparatively dry. The wash was mostly coarse and angular, some of the tinstone being of similar character, the remainder being much worn, red, or resinous, tin. The bed rock is in part altered sedimentary, the remainder aplitic granite. Mining in 1909 was almost exclusively confined to Chinese fossickers.

Albion Flat, on Cope's Creek, about 2½ miles above Tingha, Parishes Cope Creek and Swinton, County Hardinge, near junction of Stony Creek.

An alluvial flat about 150 acres in extent, the greater part of which was worked over in the early days of the field, principally by the Albion Company and has been fossicked ever since, chiefly by Chinese. Nothing of the nature of rich ground was discovered.

The bedrock is generally of a fairly even nature, but more or less strewn with water-worn granite boulders. The wash consists mainly of fragments of basalt, granite and quartz, the two former but slightly abraded, and yields on an average about five pounds of water-worn tin ore to the load. The sinking varies from 8 to 10 feet. The following section was measured in a working claim in 1909 :—

2 feet grey sandy drift.
3 feet stiff yellow clay.
3 feet coarse stony wash.
Granite bedrock.

Gov. Printer.

Beckett's Shaft, The Ponds, Tingha District.

The Melbourne Copes Creek Tin Dredging Company secured a considerable area of this flat, and installed a dredge at the junction of Stony Creek owards the end of 1909. (*See* Albion Flat Dredge.)

Baalgammon Lead.—5 miles north of Tingha, crossing Tingha–Stannifer road, Parish Herbert, County Gough.

Discovered by George Lincoln about 1873, who in 1880 held a 4-acre claim, the "Little Wonder," which is reported to have been very rich.

The lower portion of this lead is mostly recent alluvium, it joins Joe's Gully in M.L. 525, parish Herbert. Sinking up to 20 feet in reddish clay and granite sand on to a soft granite bottom. Washdirt, coarse and angular, though a considerable quantity of fine water-worn material occurs in it.

Some very rich deposits were originally worked in this lead. The lower portion was being worked in 1909 by D. G. Staschen.

Banca Mine.—M.C.P. 16, Parish Aconite, County Hardinge, 5½ miles N.W. of Copeton, ¾ miles E. of Oaky Creek.

Discovered in 1874 by L. N. Kennedy, and worked for tin and diamonds. Worked by tunnels under basalt, intermittently until about 1899, apparently no work since. The washdirt contained seams—one to two inches thick, of almost pure stream tin ore. The total yield of tin and diamonds is not ascertainable.

Beckett's Lead (also known as Pond's and Black Sand Lead), Parish Clive, County Gough, 5 miles north-west from Tingha, near the head of Pond's Creek.

Discovered about 1880, and then known as "Black Sand" Lead, owing to the large amount of black sand (ilmenite?) occurring in the upper level washdirt.

Messrs. Page and Beckett are working M.L. 214 on this lead, where the depth averages 60 feet, a descending section showing the following strata :—

5 feet.—Basalt soil.
18 feet.—Decomposed vesicular basalt.
7 feet.—Fine water-worn sandy drift (no tin).
1 ft. 6 in. to 5 ft.—Fine water-worn wash, with much black sand, averaging 20 lb. fine water-worn black tin per load.
7 ft. to 18 ft.—Decomposed basalt (not vesicular).
2 feet.—Coarse sandy drift (no tin).
1 foot.—Coarse waterworn wash (no black sand), with coarse water-worn black tin. Averaging about 50 lb. per load. Many water-worn granite boulders.
Soft granite bed-rock dipping gently north-westerly.

From the mode of occurrence of the wash, this lead represents a chain of water-holes rather than a continuous graded channel bed ; the tin deposits are, therefore, patchy though, in many instances, proved very rich. Several hundred tons of tin ore are reported to have been won from this lead ; which still continues productive in parts.

A Chinese fossicker is stated to have won 70 tons from a patch of the upper wash, about 1901, the average yield being ¾ cwt. per load.

The water in the bottom lead is easily controllable by whip-haulage.

Bellbottom Flat.—Left bank of Darby's Branch, 1 mile south-east of Tingha. Parish Cope's Creek, County Hardinge.

Alluvial and shallow surfacing, originally very rich, yielding 1 cwt. to the load over a large portion of the area.

Depth, 2 to 14 feet. Richer ground averaged about 12 feet.

Billin's Deep Lead, near south-east corner of M.L. 383, Parish Swinton, County Hardinge, 2¾ miles north-east of Tingha.

Opened about 1880, and worked for about three years. Two shafts sunk close together to depths of 65 and 68 feet, and connected by a drive, revealed (according to report) a channel averaging 50 feet wide in the western extension, with 2 feet of wash, averaging 30 lb. of coarse water-worn tin per load.

A total of about 900 feet was driven along the channel. The eastern extension averaged about 18 feet wide, with 1 foot of wash yielding 60 lb. per load. The total yield from both shafts is reported to have been 90 tons.

Following is a section of the strata at this site :—

8 feet.—Basalt clay and a little sand.
15 feet.—Decomposed basalt.
40 feet.—Hard basalt.
2 feet.—Lignitic clay.
1 foot.—Fine white sand (no tin).
2 feet.—Coarse water-worn wash, with coarse water-worn black tin.

68 feet.
Soft granite bottom.

Bird in Hand Lead.—The west-end of McMillan's lead, towards the head of Pond's Creek, is known as Bird-in-Hand Lead. This portion was worked by Messrs. McGregor and Collins. The wash varied from 1 inch to 18 inches, and was mostly coarse and water-worn, the tin partaking of the same character. The claims on this run yielded wages only, though occasional richer patches have been reported.

Black Lead (*see* Newstead Lead).

Borah Creek.—Parish Mayo, County Hardinge, C. S. Wilkinson, in 1875, reported :—

> "On the Borah Creek, which flows into the Gwydir, about 2 miles above the junction of the river with Cope's Creek, several patches of pebble drift, ironstone, and clays, capped with basalt, mark the course of a small lead. Nor far from its source the Borah Creek crosses the lead, and for about $2\frac{1}{2}$ miles further down the valley, which lies between abrupt granite ranges, it has been entirely denuded; but below this point it may be traced now and again, in a north-east direction, by patches of drift covered with basalt. It is immediately below where the creek has cut through the lead that the operations of the Borah Tin and Diamond Mining Company have been carried on in sluicing the more recent alluvial drift. Besides several tons of stream tin, upwards of 200 diamonds were obtained in a few months."*

Borthistle's Lead.—M.L. 26, Parish Herbert, County Gough, $5\frac{1}{2}$ miles north-east of Tingha. Discovered by T. Borthistle many years ago, and worked by him for some time, during which he sank several shafts averaging 135 ft. in depth, through concretionary ironstone and decomposed basalt. Width of channel wash, up to 100 ft., and from 2 to 3 ft. thick. Wash dirt consisted mainly of fine sandy drift, with angular quartz stones and some small water-worn pebbles. Occasional granite boulders occurred in it, resting on a soft granite bottom. About 40 tons of fine tin were obtained from this lead.

Later on, the northerly extension was opened by Morris and party by two shafts, each 135 ft. deep, and several tons of tin obtained.

* Mines and Minerals N.S. Wales, 1875, p. 79.

Work was continued by Messrs Connors and Schumann Bros., and later by the latter for a continuous period of four years. Two further shafts were sunk, 145 ft. and 150 ft. respectively, the last showing the following section :—

15 ft.	Ironstone (concretionary).
60 ft.	Decomposed basalt.
72 ft.	Hard basalt.
3 ft.	Fine drift wash.

Soft granite bottom, dipping gently north.

Over 900 ft. of driving was done from the 150 ft. shaft. At the north end the bottom dipped steeply into wet ground. Over 100 tons of fine tin were won by the above miners. A small bend of the lead was worked on tribute by Chinese for a yield of 18 tons. The lead is now being worked by G. Taylor on tribute from Schumann Bros.

Botterill's Shaft.—About 100 yards south-east of Firth's, Parish Swinton, County Hardinge. Commenced by C. Botterill about 1889, and worked by him for eighteen months. Shaft 136 ft., bottomed on soft granite, dipping steeply eastward ; driven north, south, and east without discovering tin wash.

Brickwood Lead.—In Portions 4, 176, and M.L.'s 208, 209, 344, and 420, Parish Swinton, County Hardinge, about 2½ miles north-west of Tingha, on Stannifer Road. Discovered by J. Martin and W. Irwin about 1879, worked by them for about two years, during which several tons of coarse water-worn tin were won. About two years later Brickwood accidentally discovered a very rich patch of tin wash, a company being formed to work it. The richest portion of the lead occurred immediately south of Brickwood House. Considerably over 1,000 tons of tin ore are reported to have been won from this discovery. Collapse of the roof in the last workings is stated to have caused their abandonment, the site of the sunken area being now marked by a dam.

The wash was characterised by iron oxide, adhering to the tinstone and cementing the drift materials ; clay and carbonate of lime were also present.

At the highest point a shaft was sunk through 150 ft. of ironstone and decomposed basalt. The bed-rock was in part granite, the remainder altered sedimentary rocks.

In the extension of the lead along the west boundary of Portion 210, a considerable amount of mining, mainly by Chinese, has been carried on of recent years, and attempts have been made to dredge the redistributed wash falling from it into Pond's or Irwin's Gully. The stiffness of the clayey overburden has, however, materially hampered operations, and militated against success.

Brickwood Extended Lead.—P.M.L. 3, Parish Swinton, County Hardinge, 2½ miles from Tingha, near Stannifer road.

Operations began on this lease about 1899. Two shafts were sunk ; the first bottomed on granite without wash, the latter being cut in a drive 100 ft. west, the lead at this point carrying about 2 ft. of coarse water-worn wash and dipping gently to the west, with 40 to 100 lb. of tin ore to the load. The shaft and drives required close timbering.

The second shaft, 400 feet west, was sunk the following year, the bedrock being reached at 150 feet, as shown in the following section :—

15 feet.—Basalt soil.
109 feet.—Hard basalt.
8 feet.—Lignitic clay.
16 feet.—Coarse sandy drift—no tin.

2 feet	Coarse water-worn wash—with coarse water-worn tin. Near the granite bottom the wash was cemented with iron oxide showing leaf impressions.

A drive west from this shaft for 400 feet along the channel averaged 18 inches of wash yielding 40 to 100 lb. of tin ore per load. The width of the channel varying from 9 to 60 feet. At the end of the west drive the channel was 6 feet wide, and the wash 1 foot thick; water very heavy.

An eastern drive was put in 250 feet across soft granite with occasional patches of wash yielding up to 50 lb. per load. From this drive a good deal of blocking out was done north and south.

The total yield from both shafts is stated to have been 60 tons of tin ore. Work ceased about 1901.

A short distance south of the shafts, on the boundary of Portion 171, is the "Potato patch," discovered by M. Partridge, about 1886; so named from the loose pieces of tinstone found in the soil. In October, 1909, a fresh find was made at depths varying from 4 to 9 feet. The largest blocks weighing from 20 to 150 lb. of pure cassiterite; 3 tons in all being obtained in the latest find. The fall from the "Potato ground" to the closely adjacent Brickwood Extended lead must be steep.

Brisbane Company.—(*See* Stannifer Freehold T.M. Coy.).

Brissett's Lead.—(*See* Last Chance).

Britannia Mine.—M.C.P. 319, Parish Darby, County Hardinge.

The Britannia Tin Mining Company owned the above block of 240 acres at the junction of Cope's Creek and Darby's Branch, fronting the south bank of each stream, on which the village of Tingha was subsequently laid out.

The following description of the original creek wash by Mr. S. W. Moore, in 1876, is of interest in the light of the almost continuous fossicking, and the recent dredging which have taken place since the description was written:—

> "The largest part of the Company's leased land is on Darby's Branch, where until recently the principal workings have been carried on. The usual depth of deposit is about 6 feet in the bed of the creek, and from 12 to 15 feet in the flats, or what is commonly called made 'ground.'
>
> The height of the wash varies considerably, in some places there being only an inch or two, and in others several feet; from 6 to 18 inches may be taken as a general average. The width of wash is decidedly narrow, seldom exceeding 15 feet, and may be averaged at 10 to 12 feet . . . As a rule the main body or run of wash takes its course along the right bank of the creek; and the best 'surfacing' is to be found stretching away from the creek, on the left bank." . . . The surfacing—*i.e.*, from the grass roots to the clay—averages from 1 foot to 18 inches, through which the tin is very irregularly scattered. Not infrequently the tin is found mixed with the clay, or passing beneath the clay is deposited in a kind of wash lying on the granite; as a rule, however, in mere "potholes."*

In 1877, it was reported that this mine was nearly worked out, the yield being less than 40 tons for the year.†

Brosnan and Party's Deep Lead Syndicate.—Operating in M.L. 347, Parish Swinton, County Hardinge, about 60 yards south-east of Guyra-Tingha road, 4 miles north-east of Tingha.

This lead was opened at the "White Shaft" about 1889 by Messrs. Billins and party. Granite bottom was reached at 120 feet. Drives west and south-east were put in 40 and 60 feet respectively. The wash averaged from 1 to 4 feet in thickness, of fine water-worn material, yielding about 2 oz.

* Ann. Rept. Dept. Mines for 1876, pp. 68, 69. † *Ibid.*, 1877, p. 104.

of medium-grade, water-worn tin per dish. Operations ceased many years ago, but in 1909 the shaft was cleaned out by the above party, revealing the following section :—

10 feet decomposed basalt.
110 feet hard basalt.
Soft granite bedrock.

Budden's Hill, Stony Creek.—Parish Swinton, County Hardinge. A small knoll of basalt overlying drift, in which numerous tunnels have been driven. Channel averaged 50 feet in width, and the wash 1 cwt. of tin ore to the load over a considerable portion. Worked intermittently for about thirty years. The following is a typical section :—

5 feet basalt clay.
30 to 40 feet basalt, mainly loose boulders.
6 inches lignite.
2 feet coarse water-worn wash, with coarse water-worn tin ore.
Granite bedrock.

Cain's Lead.—A small tributary of Jealousy Lead, 1 mile west of Stannifer.

Discovered by Cain and party in 1897, and worked until the present. Depth of sinking, 20 to 25 feet, through basalt soil and decomposed basalt. The wash varied from 6 to 12 inches of fine water-worn drift, yielding 50 lb. of tin ore to the load.

Dead Bird Lead.—Commencing a few chains west of junction of Inverell–Bundarra and Gilgai–Bundarra roads, and trending in an E.N.E. direction through M.L.'s 23, 24, Parish Clive, County Gough.

Discovered in 1890 by Kennedy, Barnett, and party, depth of sinking averaging 45 feet at upper end, increasing to 125 feet at lower. The channel varied in width from 20 feet to a few inches, probably representing a chain of ponds.

Numerous large water-worn boulders occur along the sides of the channel. A section of the strata passed through in sinking to this lead is represented below :—

12 feet ironstone, concretionary.
14 to 75 feet decomposed basalt.
2 to 2½ feet stony, water-worn wash, with numerous partly worn quartz crystals, yielding 56 lb. of water-worn tin ore per load.
Soft granite bedrock.

The wash is free from black sand. This lead was being worked by three parties in 1909.

Donegal Lead.—Parish Herbert, County Gough.—Trending from near Stannifer north-easterly to Boney Gully.

First opened at upper end by J. Mannix and R. Cooper in 1880, near Portion 10.

The Wheal Herbert Tin Mining Company in 1887 sank three shafts lower down the lead in M.L. 600, which exposed the following section :—

4 feet soil.
110 feet basalt.
1 foot wash, with small quantity of medium to coarse-grained tin ore.
Soft granite bedrock.

Channel, up to 300 feet wide, driven on for about 500 feet.

The top end of the lead near Portion 10 is reported to have been about 80 feet deep, viz. :—

40 feet concretionary ironstone and decomposed basalt.
25 feet drift sand.
2 feet coarse-wash, averaging 20 lb. tin ore per load.

The lower end, north of Inverell–Armidale Road, has been tested by several shafts, but in no instance were favourable prospects obtained. The principal shaft—Beckett's—154 feet deep, passed through 140 feet of basalt on to 2 feet of coarse rubbly drift, with only colors of tin.

Yield fifty pounds of medium to coarse-grained tin ore per load. The channel averages 10 feet in width. Worked for about 20 chains ; 40 tons of tin ore obtained.

Carney's Hill.—M.L.'s 107, 700, 331, Parish Swinton, County Hardinge, 1½ miles north of Tingha.

Worked about 1889 by P. Carney, and later by a Sydney Company, which obtained several tons of tin. No work of any importance has been carried on during past ten years. Average depth of sinking, about 30 feet, through bouldery basalt. Average thickness of coarse water-worn wash, 2½ feet, with fine water-worn tin ore. Average yield, about 10 lb. per load.

Opened by several tunnels, in addition to shafts. Sinking dry, little timber required.

Chinaman's Lead, near south-west corner of Portion 403, Parish Swinton, County Hardinge, near Tingha-Guyra road.

Discovered in 1873 by Chinese, and worked by them until 1899 ; idle since. Depth of sinking varied from 50 to 70 feet in the following strata :—

5 ft. basalt clay and granite sand.
50 ft. decomposed basalt.
1 ft. white sand, with pipeclay.
4 ft. course water-worn wash.
Soft granite bedrock.

The wash is reported to have yielded up to 80 lbs. of coarse black tin per load, and 150 tons are said to have been obtained from an area of about 3 acres in extent. The channel varied from 15 to 50 feet in width. Numerous contiguous shafts were sunk. The wash had the characteristic greenish colour of most of the deep-lead wash-dirt.

Cooper's Claim.—Between Portions 413 and 330 and M.L.'s 260 and 600, Parish Clive, County Gough, 2 miles west-north-west of Stannifer.

Operated by S. Cooper in 1890. The wash, especially under the lane between the portions mentioned, was very rich. It was first blocked out, then the whole of the overburden removed—consisting of 15 feet of decomposed basalt and 8 to 10 feet of drift sand—to enable left blocks being worked, an engine being employed to keep the open-cut unwatered ; the lead itself was dry, but difficulty arose from stormwater.

The wash was coarse and stony, with numerous partly water-worn quartz and quartzite boulders. Yield, 3 cwt. to the load—52 tons of tin ore being obtained from an acre of land comprising the lane. M.Ls. 260 and 600 were also worked by Cooper ; the lead was similar to the above, but averaged from 15 to 20 feet in width ; 100 tons of tin ore are reported to have been won from these blocks.

Cope's Creek.—The nature of the original tin-wash in this Creek was described by C. S. Wilkinson, in 1872 :—

> "Narrow alluvial flats extend along the course of Cope's Creek ; in them the alluvium seldom obtains a greater thickness than 20 feet, the wash-dirt scarcely averages 2 feet thick. The yield is from a few ounces to 8 or 10 lbs. (in some instances) of stream tin to the dish, and is generally the same in most claims, though some have yielded richer patches than others."*

* Tin-bearing country, District of Inverell, Legislative Assembly Paper, 1873, 176—A.

Copeton.—Situated on Cope's Creek, about three miles above its junction with the Gwydir River ; best known in connection with the occurrence of diamonds. Tin alone has been worked in the following mines in this district :—Lone Star, Pine Ridge, and the Two Mile, and small quantities have been obtained whilst working for diamonds in the following mines :—Crown Jewel, Round Mount, Davis', Deep Shaft, Old Farm, Soldier's Hill, Malacca, Kirk's Hill, Oakey Creek, Collas Hill, Commonwealth, Streak of Luck, and Banca.

Crystal Hill Deep Leads.—Portions 189, M.Ls. 4, 100–104, 252, Parish Single, County Hardinge, 1 mile north of Cope's Creek, and 5 miles north-east of Tingha.

Operations began here about 1884, when a shaft was sunk 150 feet through hard vesicular basalt in M.L. 252, but no wash was met with.

About 1905 Messrs. Donoghue, Thomas and party bottomed an old shaft close by with a similar result. A tunnel was then driven into the hill from M.L. 100 for a considerable distance with no better reward.

Several shafts sunk at the southern end in 1884, averaging 50 feet, struck about 1 foot of water-worn wash, with quartz and tin crystals, which led to the name of the locality. Nothing, however, of a payable nature was discovered in the shafts.

A little fine gold was found in wash on the south side of the hill by W. Duncan. Black sand (probably ilmenite) was at first mistaken for stream tin on the east side of the hill. The drift is reported to have resembled local diamantiferous wash in containing numerous so-called " bean stones," characteristic of the latter, but no diamonds were found after careful search.

A tunnel from the west boundary of M.L. 100 was driven by Duncan in a north-east direction for 200 feet ; the level being lost in several places by a series of step-like falls until the wash could not be followed further on account of water.

A bed of fine drift gradually tapered out from 3 feet thick near the entrance of the tunnel to nothing in the direction driven.

Darby's Branch.—M.L. 35, Parish Cope's Creek, County Hardinge, near junction of Apple Tree Gully.

Dredging operations commenced here about 1907, and continued for about six months. About 7 tons of coarse tin ore were won during this period. The depth of the overburden averaged 16 feet, and the wash-dirt from 2 to 3 feet. The latter was very course and somewhat irregular.

Edward's Lead, also known as Swinton's Gully Lead, and Woolshed Lead.—At north-east corner Portion 28, Parish Swinton, County Hardinge, about 4 miles north-west of Tingha.

Discovered about 1905 by Dunshea, sen., who sank through 16 feet of coarse drift sand with a little clay, to coarse gravelly wash-dirt, varying from a few inches up to 5 feet in thickness. The wash carries numerous large angular pieces of quartz, and granite boulders.

The yield was reported as 10 lb. per load in some claims ; the tin ore being medium to coarse grained. Operations hampered by defficient water supply.

Portion of the material was derived from denudation of the Victoria, McMillan's, and other leads in a northerly direction from the head of the gully.

Dick Jones' Lead.—Adjoining Tingha–Guyra road, 2 miles north-east of Tingha, in M.L.'s. 345, 177, 178, 388, &c., Parish Swinton, County Hardinge.

Of this, the first lead proved under basalt in the Tingha District, the Mining Registrar, Mr. W. S. Moore, wrote in 1876 :—

> "About four years ago Mr. Wilkinson (Government Geologist) rode over this very ground, and being struck with the formation of the country, he then confidently asserted as his belief that tin existed in payable quantities beneath the basalt ; and, I am told, even went so far as to strongly advise prospecting. But at that time, when tin was so easily obtained in the creeks and gullies and on the surface, it was no wonder that even practical men flinched from the task of breaking through a solid mass of basalt, the extent of which no one could tell, on mere spec. And it was not until Jones, some considerable time after, undertook and completed the task, that the geologist's prediction was confirmed."*

At the site of Jones' shaft, in 1872–3, the channel averaged 40 to 50 feet in width, and the wash from 6 inches to 3 feet in thickness. The depth of sinking was from 60 to 70 feet, and, with the exception of a few feet of pipeclay and drift sand, was through basalt.

The second claim proved on the lead, "The Arm," yielded 25 tons of tin ore in the first eight months, and the "Lizzie" claim nearly 50 tons during 1876.

The sinking for the whole lead averaged from 30 to 80 feet, and the basalt cover 56 feet. The channel averaged 40 to 80 feet in width, with 2 to 4 feet of mostly fine water-worn washdirt, carrying fine water-worn tin ore, with some very coarse angular tinstone, the latter evidently from adjacent lodes. On the surface of the basalt three deposits of recent alluvial drift occurred, carrying a small quantity of coarse angular wash, with slightly-worn reddish-coloured tin ore. The occurrence of reddish tin above, and black tin below, the basalt, is common in the Tingha District.

A few small slugs of native bismuth were obtained from this deep lead, and a thin vein of native bismuth is reported to have been exposed in the granite bedrock under it.

About 4 feet of white calcareous and siliceous sinter occur under the basalt.

The average yield is reported to have been about $\frac{3}{4}$ cwt. per load ; but numerous rich patches occurred in holes, probably representing "pot-holes" in the ancient stream-bed. About 1,000 tons of tin ore are estimated to have been won from this lead to date ; and a few miners are still at work, mostly on a tribute of 2 cwt. per ton.

Elsmore Hill.—Parish Anderson, County Gough. The historic site of the first tin-mining in New South Wales (see pp. 15–18). The rich shallow surfacing was at first carted to the river and treated in sluice-boxes, the first consignment of several tons being so obtained. (*S. M. Herald*, October 4, 1871.) Later, a reservoir was constructed at the top of the hill, and an engine and pump installed on the river bank, from which the necessary sluicing supply was obtained.

Of the operations and output of the pioneer company nothing is known, no records being available. Prior to the recent introduction of dredging, or, more correctly, hydraulic sluicing, the Union Tin-mining Company had possession of the M.C.Ps. (1,060 acres) secured by the original owners, Barron, Austin, and Brown. Of the latter company's doings, also, no record is available. A brief reference to this property in 1901 alludes to it as "an old mining property which in days gone by turned out as much as 600 tons

* Ann. Rept. Dept. Mines for 1876, p. 69.

annually for several years. The whole of the company's property is tin-bearing and, though operations have been confined to working the alluvial, the ground is known to contain reefs of tin, bismuth, and wolfram."*

Penberthy Bros. subsequently held the property on tribute, and during this period the surface wash was carted for treatment.

Messrs. Brown Bros., Cooper, and Co. secured the site in 1905, and installed a pumping plant on the river which forced the water to an elevation of 170 feet—insufficient, however, to reach the apex of the hill. Their interests were then disposed of to the Elsmore Tin Sluicing Company, No-Liability, in August, 1905, for the purpose of securing a pumping plant capable of raising an efficient water supply to the top of the hill, a height of 240 feet, from a distance of 28 chains. (For subsequent operations *see* under "Dredging.")

Elsmore Hill from its apex slopes all round, but most steeply to the river. The stanniferous surfacing extended from the apex about two-thirds around its circumference, the remaining third being too steep for accumulation of detritus from weathering and denudation. Down the slopes the tin-bearing granite waste passed into definite channels or "leads" under the basalt sheet, which filled the valleys and enwrapped the hills of granite and altered sedimentaries. The principal lead—known as "Penberthy's," after its discoverers—was traced into deep ground in Elsmore Valley. (*See* under these names). On the western slope of the hill are remains of an early drift, now exposed as hard cement, referred by C. S. Wilkinson, to *Miocene* time. The Elsmore occurrence he regarded as broken up and redeposited Miocene drift, forming shallow surfacing near the top of the hill, but undisturbed, and converted by siliceous cement into hard conglomerate in another part.†

A puzzling feature of both Elsmore and Newstead, and of other parts of the district where granite occurs as bedrock, is the occurrence of masses of cemented quartz sand, which in places form escarpments. The quartz grains are angular, and exhibit no trace of abrasion; at Newstead deep shaft it was pierced under the basalt directly resting on granite, further south it forms a bold escarpment. As the shaft is not now open to inspection the junction of the granular quartz rock with the granite cannot be examined. From the spoil heap, however, it seems probably that instead of a distinct line of demarcation between the two, there was a gradual transition. It is conjectured that the eurite surface undergoing decomposition and disintegration owing to kaolinization of the felspar, the latter was gradually removed in suspension by percolating waters, leaving the resistent quartz particles to be cemented by subsequent siliceous solutions following the basalt outflow.

Elsmore Valley Deep Lead.—M.Ls. 210, 211, Parish Anderson, County Gough. This lead heads at Elsmore Hill, about 90 chains from the most western shaft following its course. Between the early provings and the latter (No. 1) shaft, a distance of about 50 chains of unproved basalt-covered flat intervened.

Near the site of No. 1 shaft a bore was put down, which by great good fortune bottomed in a narrow run of very rich wash. It subsequently transpired that the drill just missed a large granite boulder, resting directly on the bedrock without intervening tin drift.

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* Ann. Rept. Dept. Mines for 1901, p. 57. † Mines and Minerals N. S. Wales, 1875, p. 78.

A shaft was sunk in 1896, which was inspected by J. B. Jaquet in 1897, who reported:—

"A borehole was put down to prospect a wide flat about half a mile west of the old workings. It passed through the centre of a rich tin-bearing lead, and entered the bedrock at a depth of 20 feet. Two leads or beds of tin-bearing gravel were passed through—an upper 10 feet thick, and a lower and richer bed 3 feet thick. A working shaft has been sunk upon the south-west side of the lead. From the bottom of the shaft a level has been driven in a north-easterly direction, which has cut the lower lead at a distance of 76 feet. The lead has been proved by drives for a length of nearly 500 feet. It trends N. 35° W., falls towards the north, has an average width of about 40 feet, and a thickness of from 1 to 3 feet.

"The plant which the company are erecting for puddling and washing is not yet completed, and no bulk tests of the wash-dirt have been made, so I am unable to speak definitely as to the amount of tin which it contains. However, a general examination of the exposed faces has made me of opinion that the gravel is of a high-grade character, and will yield good returns.

"The upper bed of gravel is much thicker (7 to 10 feet) than the lower, and contains less tin.

"About 250 loads of wash were stacked at surface awaiting treatment."*

The section exposed in No. 1 shaft consisted (according to Mr. Thomas, of Tingha) of 11 to 20 feet of soil and shingle, 100 feet of basalt, 6 feet of drift, and 100 feet of rotten sedimentaries; a total of 225 feet.

Of the operations of the original company, which was registered in 1894, (capital £15,000 in 60,000 shares of 5s.,) unfortunately no records are available. From a prospectus issued in 1908, by the Elsmore Valley Deep Lead Tin Mines, Limited, it is gathered from a report by L. C. Green, F.G.S., F.C.S., &c., that over 600 tons of tin ore were obtained from the bottom wash mainly, which is reported to have averaged 50 lb. to the load. One dividend of 3d. per share was paid in July, 1900.

Portion of the wash was cemented, necessitating crushing machinery.

The upper wash was reached by a rise from the bottom level in No. 1 shaft, but, according to Mr. Jaquet, with the exception of one crosscut, no exploratory work had been done at the date of his inspection. It is, however, reported locally that where it coalesced with the bottom bed—the latter rising up to this level, near No. 2 shaft higher up the lead—a large patch of it was worked yielding about 25 lb. to the load.

The proved width of the drift between the two shafts is stated to have varied from 20 to 200 feet. No. 2 shaft reached bedrock at 174 feet.

Exhibition Lead.—West end of Baalgammon Lead, Parish Herbert, County Gough, 1½ mile south-west of Stannifer.

Discovered in 1880 by W. A. Cross. Average depth of sinking 40 feet, ranging from 30 to 60 feet. Average width of channel, 65 feet. The overburden consisted of decomposed basalt, 8 to 10 feet of drift sand, and 1 to 1½ feet of coarse water-worn wash. Bedrock granite, bouldery and uneven. Average yield of wash, 50 lb. tin ore per load. The total yield is estimated at 200 tons.

A large portion of the lead is covered by several feet of cemented coarse drift. Water, heavy for most part.

* Ann. Rept. Dept. Mines for 1897, p. 175.

Fern Hill, Topper's Mountain.—Near centre of east boundary of M.L. 202, Parish Swinton, County Hardinge, 4½ miles north-north-east of Tingha.

Messrs. Johnstone and Martin opened the site in 1896, by a shaft 130 feet deep, piercing the following strata :—

40 feet.—Ironstone and soil.
90 feet.—Decomposed vesicular basalt.
3 to 4 feet.—Fine water-worn wash, yielding 15 lb. of fine water-worn tin ore per load
Soft granite bedrock, dipping north.

Firth's Hill Lead.—M.L. 1, Parish Swinton, County Hardinge ; about ¼ mile north-west of Tingha-Guyra road. Elevation, about 300 feet above Tingha. Discovered about 1873 by S. Firth. Most of the tin-mining at this site was carried out by an Armidale syndicate, which operated for about a year. Since then desultory work only has been carried on.

The overburden consists of a thin layer (5 to 8 feet) of pisolitic iron ore. The wash varied in thickness from 1 to 5 feet, and consisted of very water-worn pebbles, some of large size.

A bed of cemented sand bounds the lead north-west side, and continues along the junction of the granite and basalt, past the Jenning's deed shaft, to near Chellas School on the Guyra-road. It has served as a guide in locating the lead and selecting prospecting sites.

The wash on the hill outcrops in places, and is in part cemented by oxide of iron.

Firth's Shaft, sunk in 1883, near the south-east corner of M.L. 1, bottomed on granite ; the wash was cut in a southerly drive 500 feet from the shaft. It occurred in lens-shaped patches, and consisted of medium-sized well worn quartz pebbles, with somewhat coarse tin ore. The average yield was 28 lb. to the load ; but only a few cwt. were obtained.

An air shaft to cut the south drive at 1,000 feet from the main shaft, bottomed at 115 feet. The sinking gave the following section :—

5 feet basalt clay and granite sand.
40 feet decomposed basalt.
68 feet basalt easily worked.
1 foot fine white sand—no tin.
1 foot white pipe clay.
2 feet wash-dirt—only along narrow channel.
Soft granite bedrock.

Halligan's Lead.—Portion 180, M.Ls. 529, 530, Parish Swinton, County Hardinge, 4¼ miles S.E. of Gilgai.

Discovered by W. Johnson in 1884. Course, west for 14 chains, then approximately north for 30 chains. Average depth of sinking 16 feet at head, and 90 feet at lower end. Average width of channel, 30 feet, wash about 18 inches thick. Consists of somewhat angular stones with slight admixture of well-worn pebbles. Yield 25 lbs. of angular tin ore per load. Granite bottom. Output reported to be about 14 tons.

Hobson's Gully.—Rising near 11-mile post on Tingha–Inverell road, follows a general south-east course until junctioning with the "Little Wonder" Gully, near Cope's Creek.

The average depth of the recent alluvium in the gully is about 7 feet (varying from 2 to 15 feet). The bedrock consists of altered sedimentaries (Permo-Carboniferous). The clay, locally known as "slurry" arising from decomposition of the bedrock), yields from 2 to 7 lbs. of tin ore per load, whilst the "wash" yields an average of 7½ lb. This ground has been worked and fossicked for many years, with occasional good results. The scarcity of water, and the tightness of the overburden militate against success.

Humphry's Shaft.—(*see* Schumann's Lead).

Hungry Hill.—On left bank of Stony Creek, Parish Swinton, County Hardinge.

A continuation, of small extent, of Budden's Hill from which it is separated by Stony Creek. Numerous tunnels have been driven under the basalt for distances up to 150 feet. All wash practically removed. It was extremely patchy, and from 1 to 2 feet in thickness. The average yield is stated to have been about 30 lbs. of tin ore to the load, somewhat coarse and water-worn. Worked intermittently up to about 1903.

Jealousy Lead.—1 mile west of Stannifer, Parishes Clive and Herbert, County Gough.

Discovered about 1880 by W. A. Cross. Average depth of sinking 45 feet, through concretionary ironstone and decomposed basalt, as per section :—

30 to 90 feet concretionary ironstone and rotten basalt.
7 to 14 feet drift sand (in places).
6 inches to 3 feet coarse stony waterworn wash.
Soft granite bedrock. Dry.

The tin-ore was medium-grained and water-worn. The lead proved extremely rich in patches, seams of almost pure tin ore 6 inches thick were sometimes found. The average yield throughout is reported to have reached 1 cwt. to the load.

The width of the channel was about 2 chains, which was worked for a length of 40 chains. The output is estimated at about 400 tons of tin ore. Practically abandoned since 1901, though occasional fossickers still visit it.

Numerous large water-worn quartz boulders occur in the wash.

Adjoining the south end of this lead a rich claim, known as the "Sandy Block," gave the following section :—

10 to 20 feet ironstone (concretionary).
30 to 40 feet decomposed basalt.
5 to 10 feet very loose sandy drift.
2 to 3 feet coarse stony drift.
Soft granite bedrock.

Jenning's Deep Lead, M.L. 346, Parish Swinton, County Hardinge, alongside Tingha–Guyra road.

No. 1 shaft was begun by the Jennings Deep Lead Tin Mining Company N.L. in 1906, and sunk (under aid from the Prospecting Vote) 125 feet to the granite bedrock, exposing the following section :—

5 feet soil, granite sand, and basalt clay.
20 feet decomposed basalt.
100 feet hard basalt.
6 inches lignitic clay.
Soft granite bedrock.

The shaft bottoming on granite without wash, a level was driven N.N.E., striking a bouldery gutter without tin. A level was then driven north-east 51 feet, striking a gutter 10 feet wide carrying coarse angular wash with some water-worn pebbles, yielding ½ cwt. of coarse water-worn tin ore to the load. The gutter became wider as it was followed in a south-east direction. Crossing this channel, the drive was continued to a point 200 feet from the shaft where a gutter, 20 feet wide, was intersected; its course being north and south. The second channel carried similar, but much richer wash, averaging 1 cwt. to the load. The drive was continued 200 feet further in in soft granite.

From the point of intersection of the first gutter, a level was driven on its south-eastern course for 500 feet, with an average depth of 3 feet of wash for

the whole distance This wash was coarse, greenish-colcured, angular, and cemented, with coarse tin ore, becoming poorer to the south-east. About 90 tons of tin ore were obtained to date of inspection in 1909.

A second shaft was sunk for an air-shaft, about 350 feet south-easterly from the first. It yielded the following section :—

12 feet basalt clay and very decomposed basalt.
21 feet basalt, moderately easy sinking.
92 feet hard basalt, bottom 30 feet excessively hard.
3 inches lignitic clay.
35 inches soft granite.
Total depth, 160½ feet.

This basalt has been described by G. W. Card :—

"Under the microscope numerous phenocrysts of olivine lie in a granular groundmass of plagioclase, augite, magnetite, and olivine. The whole is quite fresh. The olivine phenocrysts are deeply corroded and much cracked, but still show their characteristic form in large part. The plagioclase of the groundmass is lath-shaped, but quite unoriented."

The bedrock dips rapidly to the east. A level was driven north 50° east for 131 feet. At 60 feet the lead was cut, its width being 38 feet. A level was driven along it south 40° east for 80 feet. From the end of the eastern drive a level was driven north 50° west for 140 feet, breaking into old workings.

The water in this lead averages about 1,000 to 1,500 gallons per twenty-four hours. The basalt in places is most interestingly moulded over the tops of the channel boulders. The mass of the latter reduced the available wash considerably in places, whilst the tight contact with the basalt necessitated blasting to dissociate them.

In 1909 the mine was under suspension of labour conditions either wholly or in part. The wash in No. 2 shaft proved less rich than at No. 1, but was payable and more easily worked. 23½ tons of tin ore were obtained during 1909 and 16 during 1910. Lead narrow.

Joe's Lead.—M.P. 12, M.Ls. 250, 412, Parish Clive, County Gough, near Tingha Road, 2 miles S.E. of Gilgai.

Discovered by Messrs. Stone and Brodie about 1888, mostly worked by Chinese. Average depth of sinking about 30 feet, presenting the following section :—

10 to 12 feet.—Basalt soil.
8 to 10 feet.—Decomposed basalt.
8 to 10 feet.—Partly cemented coarse sandy drift with a little tin ore.
6 inches to 1 foot—Fine water-worn wash.
1 to 2 feet.—Pipeclay, drift sand, &c.
6 inches to 2 feet.—Fine water-worn wash.
Soft granite bedrock.

Width of channel ranges up to 4 chains. Yield, about 20 lb. fine water-worn tin ore per load, accompanied by black sand. Several small diamonds are reported to have been obtained.

Joss House Flat.—Adjoining west boundary of Village of Tingha, Parish Darby, County Hardinge ; facing south side of Cope's Creek.

This flat originally comprised a considerable area of mainly shallow surface deposits on granite. The depth varied from a few inches to 12 feet. Most of the tin-bearing wash contains angular fragments of reef quartz, as well as a few water-worn quartz pebbles.

Most of the area has been worked, only isolated patches remaining which are worked by Chinese and other fossickers when water is available.

Karaula Lead.—Portion 74, Parish Anderson, County Gough. Scene of the second location of payable tin at Elsmore in 1871.

Discovered by Mrs. J. Kerr about one month after C. S. McGlew located J. Wills' find on Elsmore Hill.

Loose tin was found lying in crevices and small depressions of a bare granite slope at the lower end of what was afterwards known as "Karaula Lead," close to the Macintyre River. In 1879 the mine was purchased by the Union Tin Mining Company. A considerable amount of tin was subsequently won from this lead, In 1879 the Union Tin Mining Company purchased the mine and installed a 5-head battery and centrifugal pump, for crushing the cemented portions of the wash, and sluicing the surfacing. Between 200 and 300 tons are reported to have been crushed.

Altogether about 100 tons of tin ore were won from this short run of surfacing in the early days of the field, and fossicking has proceeded intermittently since.

Large boulders of well-worn quartz-porphyry occur in the wash, which is evidently an older and higher terrace of the original Macintyre. High up the Newstead granite ridge the wash passes into cemented and loose sand lying on rotten granite.

The greatest depth of wash and boulders is 10 to 15 feet. The drift consists of crystalline and water-worn quartz detritus, and pipeclay bands. It was mostly carted to the river for treatment.

Kirk's Hill.—Near east boundary of Portion 8, Parish Aconite, County Hardinge. A basalt hill overlying drift. Opened by tunnel from near Kirk's Creek for about 200 ft. Huge granite boulders occurred in the drift at 120 ft. The drive was continued between the boulders, where natural sluicing in the original stream had concentrated a remarkably rich patch of diamonds and fine water-worn tin ore.

Other tunnels were subsequently driven by various parties in a western direction; but nothing of importance has been done since about 1897.

Lady Mary Lead.—West end of Standard lead, 1 mile south-west of Stannifer, Parish Herbert, County Gough.

Discovered about 1881. Sinking about 60 ft. through hard ironstone and decomposed basalt; then sandy drift to 1½ to 2 ft. of coarse water-worn stony wash. Though patches up to 1 cwt. of tin to the load were obtained, this lead was comparatively poor, and was abandoned in 1894.

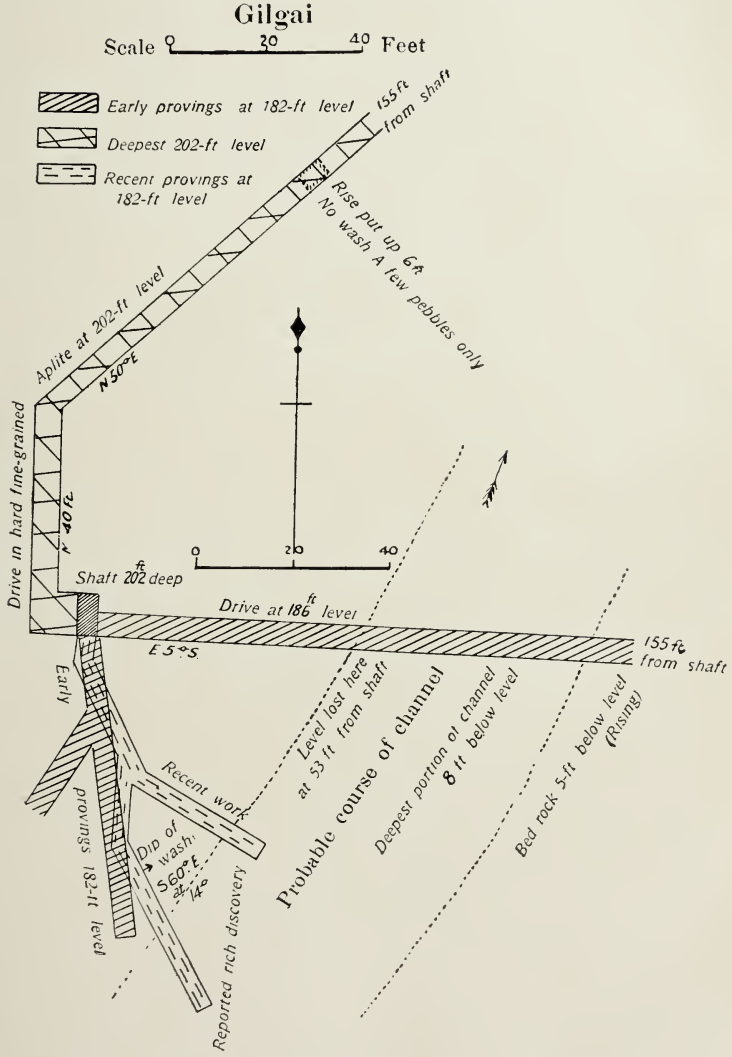
Last Chance, Brissett's, or Gilgai Deep Lead.—Portion 177, Parish Clive, County Gough, Marsh's paddock, Gilgai.

Persistent efforts have been made for a number of years to trace the northern extension of the Gilgai deep lead under the basalt sheet. At the United, Calthorpe's, and Walker's deep shafts, distant about 180 chains, payable wash had been raised in the past, but efforts to trace it further have not been rewarded. The latest—the Last Chance, is located in a deep channel; but, so far, sufficient payable wash has not yet been exposed.

The persistent efforts of Mr. John Brissett are deserving of reward. He and others, under agreement with the owner, sank a shaft through 95 ft. of basalt to granite bedrock, dipping steeply south-west. Continuing the shaft to 133 ft., a level was driven westerly for 180 ft. At 80 ft. the basalt came down to the top of the level. At 180 ft. the dip was too steep to follow.

A bore was then put down 420 ft. west from end of drive, which bottomed on granite at 101 ft. The Last Chance shaft was then started 171 ft. east of the bore under aid from the Prospecting Vote. The basalt cover was pierced at 169 ft., and the granite bedrock reached at 176 ft.

Plan of Levels at Brissett's Deep Shaft


Gilgai
Scale 0 20 40 Feet
Early provings at 182-ft level
Deepest 202-ft level
Recent provings at 182-ft level
155 ft from shaft
Rise put up 6 ft
No wash A few pebbles only
Aplite at 202-ft level
N 50° E
Drive in hard fine-grained
40 ft
0 20 40
Shaft 202 ft deep
Drive at 186 ft level
155 ft from shaft
E 5° S
Early
Recent work
Level lost here at 53 ft from shaft
Probable course of channel
Deepest portion of channel 8 ft below level
Bed rock 5-ft below level (Rising)
provings 182-ft level
Dip of wash S 60° E at 14°
Reported rich discovery

Wash. 9-in to 18-in in pockets Not rich except in absolute bottom
Not yet payable

At 182 ft. a level was driven southerly 65 ft., through boulders and drift sand, a little tin occurring on the bottom only. At the face the wash dipped and the level was lost.

At 186 ft. an eastern level was driven 113 ft., the wash dipping below it at 53 ft. At the end of the level the bedrock was reached in 5 ft., midway the gutter or channel was 8 ft., below the level.

The shaft was then deepened to 202 ft., a plat cut, and a drive started north in hard aplitic granite. At 40 ft. its bearing was changed to north 50° east, and continued a total distance of 150 ft. from the shaft. A rise at 25 ft. from the face was put up 6 ft. A few pebbles only were found on the bedrock.

Attention was then again given to the southern and south eastern provings, as shown on the accompanying plan; but the grade was soon lost in the south-eastern level, whilst the southern skirted the edge of the channel. A little tin ore is visible in patches.

It is puzzling to know why the lower level was not driven between the southern and eastern to intersect and drain the deeper portions of the proved channel, instead of driving north-easterly in hard granite to intersect it eventually about 100 feet away.

The later southerly drive, moreover, started at the same level as the previous one, which was too high to properly test the lead, and was hampered by the water following the dip. It will be necessary still to drive from the bottom of the shaft under the proved channel to drain it, and enable prospecting levels to be driven along the gutter itself.

The channel is well-defined, and from the amount of drift sand and large boulders, must have been a stream of some magnitude.

Water of excellent quality makes at the rate of about 3,000 gallons per hour, a 6-inch Cornish beam pump being used to keep it in check.

Little Wonder Gully.—Commencing near west boundary of Portion 219, Parish Swinton, County Hardinge, 4½ miles north-west of Tingha, and trending generally south-west to Cope's Creek.

Opened and worked many years ago, and still occasionally fossicked. The overburden consists of red clay and granite sand, forming shallow alluvial in the gully, and surfacing on granite near its head. The wash varies from 1 to 2 feet in thickness, and is mostly course and angular, with coarse angular tinstone. A small amount of fine water-worn quartz pebbles, and fine water-worn tin ore also occurs, indicating denudation of the adjacent basalt-covered drift a short distance north of the stream head.

The wash averaged about 7 lbs. of tinstone to the load, but some very rich patches were obtained during early operations. Water being insufficient for prolonged work has hampered mining.

Long Hole Flat, on left bank of Herding Yard Gully, near its junction with Cope's Creek, and extending north-westerly across the Tingha–Inverell road, Parish Swinton, County Hardinge.

Extensively worked in the early days of the field, supporting several hundred miners. The tin ore occurred mostly in shallow surface deposits, varying from 6 to 15 feet in depth, forming a "terrace" marking the earlier level of Cope's and Herding Yard Creeks, before the main channel was deepened through the granite bar at the site of the Village of Tingha.

Very rich patches of tin-bearing wash were frequently discovered, and fairly rich "pockets" are still occasionally unearthed by fossickers when water is available.

Part of the area is being dredged by Faulkner & Co. (*See* Blue Bell Dredge).

Louis' Gully, about 5½ miles west-north-west of Tingha, joining Cope's Creek, near Portion 111, Parish Swinton, County Hardinge.

Worked mainly by Louis Benas, now by occasional fossickers. Very shallow alluvial, averaging 3 to 4 feet. The overburden of reddish granite sand, with slight admixture of basalt clay. At the upper end, the average width of tin-bearing washdirt is about 53 feet, of an average thickness of 18 inches. A little fine tin occurs from the surface downwards, the average yield being about 5 lb. per load. The wash contains small angular stones of quartz and granite for the most part, and of quartzite and slate. The bedrock is mostly of sedimentary rocks, and fairly even. Insufficiency of water, and low average yield, have prevented much attention to this locality.

M.L. 277, Parish Clive, County Gough, 2½ miles south.south-east of Gilgai.

McLachlan and Huxley sank a shaft in this portion in 1879, through 68 feet of decomposed basalt, then through 90 feet of hard basalt; a little drift was reported at this level, accompanied by a great volume of water, which led to abandonment. Water reported stationery at 92 feet in shaft ever since.

McMaster's Surfacing, between the heads of Ah Jack's and Herding Yard Gullies, north of Portion 60, Parish Swinton, County Hardinge, 2½ miles north-north-east of Tingha.

A shallow deposit covered by a thin capping of pisolitic ironstone; depth, 1 to 15 feet. Wash very water-worn, with some large stones; probably a continuation of the Firth's Hill channel, about 25 chains easterly. Contains a little water-worn tin ore. Originally worked by McMaster, subsequently by Chinese.

McMillan's Lead, 4½ miles north-north-west of Tingha, near north boundary of Parish Swinton, County Hardinge.

Discovered by H. McMillan in 1880, worked by him and Ryan for two years, during which they obtained 20 tons of coarse water-worn tin ore. A section of the average sinking exhibits the following strata:—

44 feet of basalt soil, with some ironstone and decomposed basalt.
3 to 4 feet coarse water-worn wash, with many large quartz stones.
Soft granite bedrock.

It is reported that no defined channel was discovered at McMillan's, the wash-dirt being spread out in places over 300 feet wide; short runs in various directions were occasionally followed, but the ground, on the whole, was patchy. The average depth was about 50 feet.

McMillan's shaft passed through the following strata:—

8 feet basalt clay.
37 feet decomposed basalt.
6 inches fine white sandy drift, with a little fine water-worn tin ore.
2 feet coarse stony wash, with large angular lumps of white quartz.
Soft granite bedrock.

The wash yielded an average of 1 cwt. of coarse water-worn tin ore to the load.

Considerable driving was done in a western direction and a lesser amount in an eastern, following the tin, the width averaging 60 feet.

About 1901, D. G. Staschen sank a shaft close to McMillan's, the wash yielding ¾ cwt. per load in places, but was patchy.

Malacca Diamond Mines (Limited), Copeton.—The yield of tin from the Copeton diamantiferous wash is indicated by the return from this company's operations during 1906, viz., 4 tons 5 cwt. from 1,800 loads, equal to 5¼ lb. of tin ore to the load.

Markham's Lead.—Commencing near the east boundary of M.L. 345, Parish Swinton, County Hardinge, and trending E.S.E. for about 15 chains, with a width of 4 chains. Worked, about 1879, at the lower end, but only recently in the upper. The following section of the latter is typical :—

1 to 6 feet granite sand and basalt clay.
12 feet decomposed basalt.
3 to 4 feet white clay, with some granite sand.
1 foot (average) fine water-worn wash, with large amount of coarse angular quartz stones, with fine water-worn tin ore, the average yield being 50 lb. to the load.
Soft granite bedrock.

The basalt cover thins out down the lead, the wash appearing on the surface.

During 1906, 146 loads were treated for 3½ tons of tin ore.

Morris' Hill, on right bank of Stony Creek, just above junction of Green Gully, near south-east corner M L. 383, Parish Swinton, County Hardinge. A low ridge of basalt. Numerous tunnels have been driven in the wash which immediately underlies the basalt, the most important being Morris' tunnel, at south-east corner of M.L. 383. This tunnel, according to report, passed through 70 feet of fairly hard blue granite, then 150 feet decomposed granite to the channel, which proved 300 feet wide, and dipped gradually north-westerly. A considerable flow of water, which still continues, was met at 850 feet, finally causing abandonment at 900 feet. The wash was from to 2 feet thick, mostly of coarse and water-worn material. Reported yield, from 28 to 56 lb. tin ore per load. Abandoned since 1884. Neil Glass' tunnel under the same basalt sheet about 300 yards west of Morris' was driven 100 feet north through granite bedrock to intersect the latter tunnel at 800 feet from entrance. The wash was then blocked out on the west side for a reported yield of 28. lb per load ; this tunnel was practically dry.

Morgan Syndicate Mine.—Portion 570, Parish Herbert. County Gough, Topper's Mountain.

Shaft bottomed at 100 feet exposing the following section :—

17 feet decomposed vesicular basalt.
83 feet hard basalt.
2 feet fine sandy drift with a very little tin on bottom.
1 foot fine water-worn wash-dirt, with fine water-worn pebbles chiefly of sedimentary rocks.
Soft granite bedrock, dipping gently north-east.

Much water was struck in this shaft causing abandonment. In 1909 it was again worked by the above syndicate, who drove north-east on the dip, the wash was reported to become coarser in that direction, and to yield 8 lb. of medium-grained water-worn tin ore per load. Granite boulders occur in the channel. About 3 chains south-west, another shaft was bottomed on granite (without wash) dipping north-east, which induced sinking of the present working shaft.

Neil Glass Shaft —In flat near Stony Creek, near east boundary of portion 18, Parish Swinton, County Hardinge. Commenced about 1889 by Neil Glass, and worked by him for about three and a half years. The shaft passed through the following strata :—

5 feet basalt clay and granite sand.
30 feet decomposed basalt.
40 feet hard basalt.
2 feet lignitic clay.
2 feet coarse water-worn wash.
Soft granite bedrock, dipping north-westerly.
Water moderate, kept down by whim.

The wash is reported to have yielded up to 1 cwt. of tin ore per load, about 70 tons in all being obtained; mostly in a westerly direction from the shaft.

Two other shafts were sunk near the centre of the west boundary of the portion, but the first bottomed high on granite, and very little wash was found in the second or northernmost. These were sunk in 1892.

Newstead Deep Lead.—M.Ls. 67, 68, Parish Anderson, County Gough, on south bank of Newstead or King's Creek.

The site was originally taken up as Portion 73 by D. S. Anderson, of Newstead Station, shortly after the Elsmore Mine was started in 1871, the site of the tin-bearing wash being pointed out to him by Joseph Wills. Portions 63, 64, 65, 67, and M.Ls. 100, 265, and 32, were subsequently secured by Mr. Anderson and the late Sir Saul Samuel, and floated as the Newstead Tin Mining Company.

No record is available of the operations or output of this company. According to Mr. F. W. Penberthy, however, the heads of the lead and adjacent surfacing were worked more or less continuously by miners for twenty-five years; proving rich, but patchy in places; the yield being from 2 to 3 cwt. of tin ore per load.

The "Black Lead," or upper end of the Newstead basalt-covered lead, is still being worked, and affords employment for a limited number of miners. Fossickers also still work occasionally in the shallower ground.

For about 15 chains the lead maintained a fairly level course, when a steep fall of 130 feet occurred in the lower or northern extension forming the "Newstead Deep Lead," on the south bank of Newstead Creek.

Above the fall the Newstead Syndicate are reported to have won 35 tons of tin ore.

The Writer is indebted to Mr. J. Kerr, of Elsmore, for the following particulars of the latest developments :—

No. 1 shaft was sunk 180 feet, and a level driven 100 feet north 65° east. At 40 feet in the level a drive was put in N. 65° E. towards the creek: from the latter a winze was sunk 12 feet and a drive put in 40 feet to N. 20° E. At the end of this drive a bed of wash was cut of a reported thickness of 9 feet, with very large boulders, and tin ore in the crevices.

No 2 shaft was then sunk to intersect the lead at a lower level, about 300 feet distant. This shaft passed through 40 feet of basalt on to acid granite with little mica or rather into several feet of cemented quartz grains, which gradually passed into granite with large crystals of felspar. Sinking was continued in the granite to 200 feet. At 190 feet a level was driven towards the old workings from No. 1 shaft. At 100 feet a rise was put up 15 feet, and an upper level continued for 90 feet. At the end of the latter a rise was put up 4 feet, and from it a due east drive extended 100 feet. A winze was sunk directly under Newstead Creek; a level from it cut basalt at 20 feet, and a bore put down in the latter, struck gas and water which drove the miners out, and caused loss of tools.

Messrs. Watkins and Amos subsequently had the shaft deepened to 280 feet in granite, and a due east level driven from the bottom, at 100 feet from the shaft a rise was put up 41 feet, but failed to reach the surface of the granite.

A level was also driven 80 feet N. 25° W., from the 70 feet level in the main or No. 2 shaft, and east for 20 feet, when operations ceased.

The shaft is a substantial one, timbered, and divided, but the poppet heads have been removed.

Though the possibilities of the Newstead and Elsmore deep leads have not yet been exhaustively tested, it is well to bear in mind that the entire area of stanniferous granite in this locality is very circumscribed, and therefore unlikely to furnish extensive supplies of tin drift, particularly in view of the sparse dissemination of the cassiterite in the granite itself. Both the Newstead (Black), and Elsmore (Penberthy's) leads proved rich in their upper reaches near the source of supply, and neither have been followed for any great distance in the deepest ground beyond actual stoping. In the case of Newstead, the deep bore (420 feet) near the junction of Newstead Creek, with the Macintyre, is too far below the source, and the record of strata passed through too doubtful, to be accepted as conclusive. It is, moreover, extremely probable that a great part of its depth is in granite.

The bores put down 34 chains west of the Elsmore Valley, No. 1 shaft, are also too far below the workings, and two far apart—4 chains—to offer a fair chance of locating a gutter, probably not more than 30 feet wide, in an extensive basalt flat.

There is also the probability of a deep lead near the old Karaula shallow surfacing where the basalt forms the bed of the present Macintyre River above the junction with Newstead Creek. This site appears to be worthy of some attention.

Oaky Creek, six miles south-west of Copeton.—Tin was discovered here about 1875 by Messrs. R. Flemming and W. Yule, who drove a tunnel—the Shamrock—near the centre of M.L. 1, Parish Aconite, County Hardinge, for a distance of about 200 feet, following a channel in an easterly direction. Several tons of fine waterworn tin ore, and a number of diamonds, are reported to have been obtained. The wash varied from a few inches to 18 inches of fine drift material, with well-worn quartz pebbles and tourmalines, the latter usually in rounded prisms.

The mine was then disposed of to a local syndicate, who did little further development, owing to the bottom of the lead dipping steeply to the east, and the presence of heavy water. After some years, G. Skippen and party continued driving at the top level of the tunnel, obtaining a small quantity of tin ; the steep dip of the wash again caused abandonment.

During the diamond "boom" of about 1894, the locality again received attention, but the low price of tin ore locally (about £28 per ton) prevented successful operation. The land was then purchased by the Australian Diamond Fields Company (London), and a low-level tunnel driven from each side of Oaky Creek.

The eastern—known as Browning's—tunnel was driven 600 feet through hard, coarse-grained granite, without meeting wash. At the end an incline rise was put up 30 feet. The night following a breakaway occurred, and water and sand streamed down in such volume as to cause abandonment of the tunnel, from the mouth of which water continues to flow.

The western tunnel (opposite Pike's Diamond Claim) was driven 490 feet. At the mouth of the tunnel seams of iron oxide, an inch thick, and cemented drift were passed through for 20 feet. The tunnel then passed through granite for 400 feet. At this point the overlying drifts, with from 6 to 8 inches of washdirt resting on the granite bedrock, were intersected. A green diamond, weighing $1\frac{1}{4}$ carats, was obtained, with fine water-worn black tin ore and a little gold. After timbering through the channel (20 feet) the tunnel was continued in granite. Water was heavy, and still flows, after twelve years' abandonment.

In 1902, Mr. A. R. Pike took up M.L. 32 to prospect for the diamond matrix. Near the centre of this block a low-level tunnel had been driven by Messrs, O'Donnell and Davis, through hard, coarse-grained granite. At 145 feet a

bar was met, which the prospectors mistook for sedimentary rock, locally known as "trap." Pike, however, proving it to be a dolerite dyke, carried on prospecting for diamonds in it, and succeeded in finding one *in situ* in the dolerite. After passing through the dolerite, the tunnel was continued in granite for a total distance of 600 feet. At the end a rise was put up 26 feet, when 9 inches of wash was reached, dipping north; water also made. This thin bed of wash yields about 28 lb. of tin ore to the load.

Near the east boundary of the same portion, Davis and Cox drove a high-level tunnel in a northerly direction. Tin was found at 212 feet from entrance, and followed for 80 feet. It occurred in wash of a thickness of 1 inch to 1 foot, which dipped into very wet ground.

Orchard's Shaft, Topper's Mountain.—(See Schumann's Lead.)

Percy's Lead, on north boundary of Portion 407, and running through Portions 335, 420, 157, and M.L. 230, Parish Clive, County Gough; 1½ mile S.E. of Gilgai.

Discovered by W. Russ about 1888. Average depth of sinking, 70 feet, revealing the following section :—

8 to 10 feet basalt soil.
54 to 57 feet decomposed basalt.
1 foot sandy drift.
1 foot 3 inches fine water-worn wash, yielding 1¼ cwt. tin ore per load.
12 feet drift sand.
2 feet coarse stony wash, yielding 1 cwt. tin ore per load.
Soft granite bedrock, dipping west.

The tinstone was mainly fine and water-worn. Average width of channel, 80 feet; worked for about 10 chains in length, chiefly by Russ and Percy; now by Hausen. Reported to have yielded upwards of £10,000 worth of tin ore.

Pinchgut Lead, near head of Topper's Gully, 5 miles N. of Tingha, Parish Herbert, County Gough.

Discovered about 1884 by W. Swan. Reopened about 1899. Greatest development has taken place within the past few years, chiefly through J. Lock.

A section of the strata passed through in sinking is as follows :—

1 to 2 feet coarse granite sand with red basalt clay.
5 to 8 feet red and black clay.
8 feet decomposed basalt, partly vesicular.
6 inches to 1 foot of mostly coarse angular washdirt, overlaid by a few inches of fine sandy drift, yielding from 7 lb. to 30 lb. of coarse red and black tin ore per load.
Soft granite bedrock.

Width of channel varied up to 20 feet at widest. Considerable water was encountered on the north-west side of the lead.

Pott's Gully (also known as Grass Hut Gully), about ¾ mile west of Irwin's Gully, 3½ miles north-west of Tingha, crossing Tingha-Inverell road, near 13-mile post.

Overburden from 10 to 20 feet in thickness, consisting of granite sand and yellow clay. The wash dirt mostly coarse, with much angular stone, and pellets of ironstone. The tin ore is generally coarse and water-worn, and of reddish-black colour. Yields up to 1 lb. per dish have been obtained, but the average was low. Channel very narrow, becoming wider towards its head, where a few Chinese still fossick out small quantities of tin when water is available. General work ceased about 1905, though a few Europeans worked here at intervals since.

Puzzle Lead, near Portion 455, Parish Clive, County Gough, 1¾ miles east-south-east of Gilgai.

Discovered about 1886, by N. M. Kennedy. Average depth of sinking about 10 feet at north-east end, and 60 feet at south-west. At the former the lead is covered by ironstone (pisolitic), and at the latter by decomposed basalt. The channel is very narrow—only a few feet at the upper end; and the wash consisted of coarse angular material carrying fine, water-worn tin ore in small proportion. Adjoining the Tingha-Inverell road it is sometimes known as "McCool's Lead." Abandoned for some years.

Quart Pot Gully, 2½ miles north of Howell, Parish Mayo, County Hardinge. Worked for alluvial tin from near Cope's Creek up to junction of Howell and Copeton–Tingha roads. Upper part pegged for dredging purposes, in 1909. Between Quart Pot and Two-mile Creek is a rugged granite range (locally known as Bald Mountain), which is partially dissected by Oliver's Gully and the heads of the Two Mile, in the direction of Quart Pot Gully. Numerous small lodes occur in the range with sparsely disseminated tinstone; the denudation of these has fed the local drainage channels.*

Red Hill, 5 miles east of Tingha, and ¾ miles south of Cope's Creek, between it and Darby's branch, mainly in Portion 211, Parish Cope's Creek, County Hardinge.

Tin was first discovered under the Red Hill basalt, by Conrad Bower, who commenced tunnelling near the north-east corner of Portion 216, in 1881. This tunnel penetrated the hill in an eastern direction for 450 feet. At 100 feet the lead was struck, but dipping steeply for 10 feet, made much water. A low-level tunnel was then driven to the wash, but the returns were not encouraging.

In shafts at the heads of these tunnels the following strata were passed through :—

5 feet decomposed basalt and red clay.
30 feet vesicular basalt, moderately easy working.
10 to 12 feet grey sandy drift.
2 to 3 feet pipeclay, with plant remains.
3 to 4 feet fine water-worn wash, with medium-grained tin ore.
Granite bedrock.

The prospector, C. Bower, also drove a tunnel at the north-west corner of Portion 211, east for 1,000 feet under the basalt, operations lasting three years, during which 30 tons of medium-grained ore were won. The wash was from 1 to 3½ feet thick, and consisted of well-worn gravel. Shafts drained by this tunnel passed through the following strata :—

5 feet decomposed basalt and red clay.
60 to 70 feet hard basalt, vesicular in part, requiring explosives.
10 to 12 feet, loose, grey, fine sandy drift.
1 to 3 feet pipeclay, with plant remains.
3½ feet coarse, grey, stony wash, with medium-grained black tin ore.
Granite bedrock, even, and strewn with a few granite boulders.

The Red Hill Tin Mining Company then drove several tunnels in Portion 211 at too high a level, finally attaining their object in one 36 feet lower than the first; this was driven 800 feet, and then westerly along the wash for 500 feet. During their operations between 1884 and 1897, 190 tons of tin ore are reported to have been obtained. A shaft sunk to the wash near the end of the last tunnel passed through strata very similar to those already recorded.

* Fox's Garnet Lode occurs on the east side of Bald Mountain to the west of Portion 33, Parish Mayo, County Hardinge. The garnets are well formed crystals in chlorite schist, and associated with zinc blende.

W. H. J. Slee reported in 1884 that the Red Hill Company had tunnelled 1,000 feet, the wash being 1 to 2 feet thick, and yielding about 1 cwt. per load. A considerable amount of associated ilmenite (titanic iron) caused trouble in final streaming.*

Shafts sunk by the Company along the east boundary passed through the following strata :—

5 feet decomposed basalt and red clay.
50 feet hard basalt, shooting ground.
10 feet green sandy drift.
10 feet purple mudstone, with plant remains.
12 feet gray sand drift (fine).
2 to 3 feet coarse water-worn washdirt.
Granite bedrock.

G. Taylor began a tunnel in 1903 near the centre of M.L. 83, and drove a total distance of 800 feet westerly. At 300 feet a "rise" of 12 feet tapped the wash. These workings were abandoned in 1908, after about 10 tons of tin ore had been obtained.

Red Hill.—Inverell–Armidale road, near Stannifer, at head of Sheep Station Gully. A small knoll of bauxitic iron ore after basalt, overlying drift.

Richardson's Lead.—M.L.'s 12 and 13, Parish Herbert, County Gough, falling from Inverell–Armidale road to Middle Creek, above Stannifer.

Opened by H. Richardson, T. Leahy and others in 1879. Depth of sinking, 18 to 20 feet. Channel, 50 to 60 feet wide; wash, 3 feet thick; yield, 1 cwt. of tin ore per load.

Rooney's Lead.—Portions 336, 420, Parish Clive, County Gough. 1½ miles south of Gilgai, alongside Gilgai–Bundarra road.

Discovered by W. Yule about 1889; worked intermittently since. Average depth of sinking 86 feet :—

44 feet basalt soil and decomposed basalt.
40 feet hard basalt.
2 feet sandy drift.
Granite bedrock.

Width of channel varies up to 80 feet; washdirt about 8 inches thick, consisting of stony, angular material, with few water-worn pebbles. Yields on an average 28 lb. of coarse, water-worn tin ore per load. Worked mainly by Messrs. Rooney, Wetzler, and others.

Rowe's Lead, adjoining Tingha–Guyra road, near north-west corner of Portion 403, Parish Swinton, County Hardinge.

Messrs. Rowe, Firth, and Sain sank to this lead about 1882, and worked it for about two years. The shaft bottomed on granite, was deepened 30 feet, and a drive from this level struck the lead in 40 feet north-east. The channel averaged from 60 to 70 feet in width, with 2 to 3 feet of wash, yielding ¾ to 1 cwt. of tin ore per load. A total of 153 tons are reported to have been obtained.

The following section was exposed in sinking :—

1 foot 6 inches basalt clay, with a little water-worn wash, carrying 5 lb. medium grained reddish tin ore per load.
30 feet decomposed basalt.
45 feet hard basalt.
6 feet lignitic clays.
6 inches fine white sand, no tin.
2 to 3 feet coarse water-worn washdirt, with medium-grained tin ore.
Granite bedrock.

Schumann's Lead.—M.Ls. 14, 16. 17, 33, Parish Herbert, County Gough. Topper's Mountain, 5 miles N.E. of Tingha.

* Ann. Rept. Dept. Mines for 1884, p. 124.

This tributary of the main deep lead at Topper's Mountain was discovered by G. and W. Schumann in 1905, and has since been continuously worked down stream, its general trend being N.W. The first shaft was sunk at the S.E. end; passing through the following strata :—

30 feet concretionary ironstone (chiefly) and soil.
100 feet decomposed vesicular basalt.
2 feet fine sandy wash.
Soft granite bedrock, dipping north-west.

The lower surface of the basalt is characterised by polished "slippy heads," and mottling due to secondary amygdales in the vesicular basalt.

The channel varied from 25 to 80 feet in width, and the wash averaged 18 inches in thickness. Bedrock uneven, and strewn with large water-worn boulders. The wash is chiefly drift sand, with a few angular quartz stones, and yields an average of about 45 lbs. of fine, partly worn tin ore per load. Occasional richer patches occur.

The lead was driven along north-west for a total distance of 20 chains. Four shafts have been sunk at nearly equal distances apart to meet the above drive. About 100 tons of tin ore have been won from this lead, which is dry, and requires little timbering.

The south-eastern extension of the lead has been worked by Orchard and Party in M.L. 33 from 1906 ; in this direction the overburden gradually shallows to 90 feet. The wash maintained an average thickness of about 18 inches, as at Schumann's, and an equal yield.

At the north-west end, Messrs. Humphry and Hutchinson sank several shafts, and succeeded in locating 9 inches to 3 feet of washdirt in the third in November, 1909, at a depth of 142 feet. Channel 60 to 70 feet wide. About 11 tons of tin ore obtained to end of 1910.

In sinking, the following section was exposed :—

3 inch soil.
116 feet soft rotted basalt.
29 feet hard basalt.
9 inches to 3 feet wash.
Soft granite bedrock.

Scott and Grey's Lead.—Portion 312, Parish Clive, County Gough, near Gilgai.

Discovered by the owners named in 1900 : worked continuously since. Sinking about 30 feet through soil and rotten basalt. The wash occurs in depressions in the granite bedrock, associated with immense boulders of well-worn quartz, the largest about one ton weight. These quartz masses are internally well crystallized, and fragile under the hammer. So far as the workings extend, no trace of such large reef-masses have been encountered in the bedrock. Hence the old stream must have had a powerful current to be able to transport such masses. The level of the bedrock is about 150 feet above that of the Gilgai Deep Lead in Brissett's "Last Chance" shaft, and may, possibly, have been tributary thereto

Like many of the old leads in the granite area, the depressions, or basin-shaped patches of wash, may represent a chain of ponds or water-holes, such as characterise many of the present channels. The sinking in this portion is illustrated by the following section of the last shaft sunk to August, 1909.

6 to 7 feet red loamy soil.
4 to 5 feet soft basalt.
14 feet sand.
3 to 18 inches wash.
Granite bedrock.

Four tons of tin ore were obtained from 100 loads of wash in 1909. About 50 chains north-east—near east boundary of Portion 183, Parish Clive, tunnels have been driven under the basalt for several hundred feet under Prospecting Aid, in search of a lead, without discovering payable tin ore.

Sheep Station Gully.—Parish Herbert, County Gough. First opened by J. Mannix, R. Cooper, W. Youl, and D. Mooney, in 1879. Sinking 20 to 40 ft. Worked extensively for about 1½ miles to junction with Middle Creek at Stannifer. Channel 20 to 400 ft. wide. Wash, 12 to 18 in. Yield, 1 cwt. per load. In parts tin occurred from grass roots to granite bedrock.

Shivery Gully.—Rising near May's surfacing, and trending past the south boundary of M.L. 349, Parish Swinton, County Hardinge, and joining Irwin's Gully near M.L. 331, 1½ miles N.N.W. of Tingha.

Discovered in the early seventies at the commencement of local tin mining, and worked intermittently ever since. The sinking varies from 8 to 22 ft., of granite sand, and clay, on to soft granite bedrock. The washdirt varies from 9 in. to 6 ft. in thickness, of strong angular material, yielding from 14 lb. to 2 cwt. of coarse angular tin ore per load, free from black sand. Width of channel, approximately 7 chains. Operations hampered at intervals by insufficient water.

Slurry Gully.—Left-hand branch of Chain of Ponds, or Irwin's Gully, about 2 miles north of Tingha; trending south-westerly to the Main Gully, immediately south of Tingha–Inverell road.

A small patch of Tertiary drift was worked near the head of the gully, but the greater portion consists of recent alluvium. Sinking averages about 10 ft. Worked for many years, and still fossicked whenever water is available. Several rich patches have been struck. The tin ore is mostly coarse and angular, but a little fine red and black tin is also present.

A dredging lease was taken up near the junction with Irwin's Gully, but boring tests did not encourage further expenditure. Here the ground runs to 20 ft. in depth. The upper portion of the gully is in sedimentary rock, the disintegration of which produces the fine sand known as "slurry"—hence the name.

Staine's Lead.—Adjoining Pinchgut Lead, Topper's Gully, about 5 miles north of Tingha, Parish Herbert, County Gough (also known as Chinaman's Lead). Worked on tribute by Chinese in M.L. 215. Worked intermittently since, mostly by Chinese. Following is a section of the strata overlying the lead:—

10 ft., concretionary ironstone, mostly.
16 ft., decomposed basalt.
1 ft., drift sand, with a little tin in places.
9 in. to 1½ ft., Coarse angular wash-dirt, with some water-worn pebbles, averaging about 40 lb. of tin ore per load.
Soft granite bedrock.

The washdirt is patchy, portions yield as much as 2 cwt. per load. Western portion of lead mainly recent alluvium.

Standard Lead.—Portions 507, 509, 110, &c., Parish Herbert, County Gough; 3½ miles south-west of Stannifer.

Discovered by the Wood's Syndicate (Inverell) in 1880. Average depth of sinking, 40 to 50 ft., through decomposed basalt, and sandy drift, to coarse water-worn wash, yielding on an average 1½ cwt. of medium-grained water-worn tin ore per load.

The channel averaged 50 ft. in width, and was worked for about 40 chains. Rich patches occurred at intervals. Several important claims worked, chief of which were the 4 Acres, Standard, and McGarry's.

A section of the sinking in the latter in portion 600 was as follows :—

42 ft., decomposed basalt.
12 to 14 ft., drift sand, with some fine tin ore.
6 in. to 2 ft., coarse stony wash, yielding 1½ cwt. per load,
Soft granite bedrock, dipping north-west.

Three hundred tons of tin ore reported to have been obtained from this lead.

Stannifer Freehold Deep Lead Tin Mining Company, Limited.—R. S. Lang, Secretary, 272 Queen-street, Brisbane. The company's shaft at Topper's Mountain is best known locally as the "Brisbane Shaft." Situated near centre of south boundary of Portion 229, Parish Herbert, County Gough. Shaft sunk in 1882 to a depth of 120 ft.; abandoned owing to water difficulty.

The present company began operations in 1906, and subsequently bottomed a shaft at 153 ft., passing through the following strata :—

79 ft., decomposed basalt.
63½ ft., hard basalt.
4 ft., blue clay.
3½ ft., drift sand (no tin).
3 ft., coarse water-worn wash.
Soft granite bedrock, dipping gently south-west.

A level was then driven 112 ft. east. At 20 ft. from the shaft a thin seam of fine wash was struck. Large boulders of fine-grained, very acid grey granite were met at end of drive on rising bottom.

A level 100 ft. north followed washdirt, of an average thickness of 2 ft., with alternate patches of rich tin ore and black sand. A level was then driven 110 ft. through fairly rich wash, averaging 18 in. thick. The wash averages 46 lb. of medium-grained, water-worn black tin ore per load.

The wash is puddled at the shaft in a Ballarat steam puddler, installed at the brace level, water being pumped from the mine at the rate of 900 gallons per hour. The shaft is divided into three compartments with double-line cages.*

Stannifer Red Lead.—Embracing Jealousy, Standard, Exhibition, and Baalgammon Leads (*q.v.*).

Stark's Lead, near north-east corner Portion 22, Parish Clive, County Gough, alongside Gilgai–Pond's Road, 1½ miles east of Gilgai.

Discovered about 1884 by Stark and Macarty. Depth, 10 to 27 feet, sinking through concretionary iron and basalt soil. A seam of oxide of iron covers the wash; which averages about 4 inches of fine water-worn, stony material, carrying fine water-worn tin ore. Width of channel about 30 feet, trend about east and west. Numerous partly worn quartz boulders occur in it. Worked until about 1908.

Starlight Extended Lead.—M.L. 411, Parish Swinton, County Hardinge. Opened about 1883, and worked for three years. Width of channel varied from 50 to 100 feet. About 200 tons of medium-grained tin ore obtained. The strata passed through exhibited the following section :—

5 feet basalt clay.
85 feet decomposed basalt.
1 foot lignite.
1 foot white sand.
2 feet coarse water-worn sand.
Soft granite bedrock.

* The output during 1909 and 1910 amounted to 25 tons from 4,979 cubic yards of wash, equal to 11·2 lb. per cubic yard.

Stars and Stripes Lead, adjoining Starlight Extended, at south-west end; 2 miles north-east of Tingha, near Tingha–Guyra Road.

Discovered about 1879. Depth of sinking averages 75 feet, exposing the following section :—

7 feet basalt clay, with a little granite sand.
65 feet decomposed basalt.
2 feet coarse water-worn wash, with much stone.
Soft granite bedrock.

Channel 30 to 100 feet wide, with occasional granite boulders. About 100 tons of tin won from about 4 acres of ground.

Star Gully.—Left bank of Herding Yard Gully, one mile north of Tingha. A considerable amount of work was done in this shallow run in the past, and much tin is reported to have been won from it.

Since introduction of dredging, the No. 2 plant of the Melbourne–Cope's Creek Company operated here for some time (see under that Company), but the yield was not encouraging towards the last, and operations were much hampered by insufficiency of water. The over-burden averaged about 20 feet, and the wash from a few inches to 2 feet.

Ten-mile Lead.—Crosses Inverell–Tingha Road at 10-mile peg, Parish Swinton, County Hardinge.

Discovered by J. Wetzler in 1888. Average depth of sinking, from 20 to 40 feet through ironstone and decomposed basalt, to 3 or 4 feet of fine sandy drift, overlying an average thickness of 2 feet of washdirt, which yielded $\frac{3}{4}$ cwt. of coarse angular tin ore per load. At the west end the wash consisted mainly of coarse, partly worn pieces of quartz and quartz crystals. Worked for about 17 chains. Channel dry; no black sand present. About 65 tons of tin ore are reported to have been won. Abandoned about 1907.

The "Potato Patch" (see Partridge's Lode and Brickwood Extended Lead).

The Oaks Lead, 3 miles south-east of Gilgai, Parish Clive, County Gough, near M.L. 609.

Discovered by P. Birtleson about 1903, and worked intermittently since. The average sinking, through decomposed basalt soil and a little drift sand, is 25 to 30 feet. Average thickness of wash-dirt, 18 inches. Yield about 20 lb. of fine water-worn tin ore per load; a little coarse angular tin, and odd pieces of wood tin also occur. General trend of lead north-east. Channel averages about 30 feet in width.

Timm's Lead, in Portions 22, 21, 40, 176, and M.Ls. 557 and 495, Parish Clive, County Gough, half a mile south of Gilgai.

Discovered about 1877 by A. Timms, and mainly worked by him. Sinking averaged 35 feet through columnar basalt. Width of channel about 1 chain. Wash-dirt coarse and water-worn, carrying fine water-worn black tin ore. Although only a few inches thick it was very rich. Worked until recently by Wetzler and others; practically exhausted.

Tingha United Tin Mine, near east boundary of M.L. 411, Parish Swinton, County Hardinge.

Opened about 1899, and worked for about eight months. Shaft sunk 101 feet through the following strata :—

5 feet basalt clay.
7 feet decomposed basalt.
17 feet lignitic clay.
1 foot coarse water-worn wash.
Soft granite bedrock.

Yield about 10 tons of coarse water-worn black tin ore, averaging about 50 lb. per load. Black sand rather plentifully associated with the tin ore.

Tom Wright's Gully, Parish Herbert, County Gough. North-west of Stormer's Rock Hole Lode, Shallow alluvial 3 to 6 feet deep.

Topper's Mountain Lead. A number of shafts have been sunk through the Topper's Mountain basalt sheet between Schumann's Lead and Brickwood. Wood's, White's, and Lock and Curry's are amongst the principal.

Wood's Shaft, near west boundary of M.L. 201, Parish Swinton, County Hardinge, 4 miles north north-east of Tingha.

Sunk in 1886, bottoming at 110 feet on soft granite overlain by about 10 feet of fine sandy drift, containing very little fine water-worn tin ore. A drive southerly for some distance struck a narrow channel with sandy drift, and a few small pebbles, which yielded 28 lb. of fine water-worn tin ore per load. Heavy water necessitated steam power to cope with it. Abandoned for some years.

White's Shaft, near south boundary of M.L. 207. Commenced in 1886, bottomed on soft granite at 135 feet, driven north-west across channel. Some rich patches of wash obtained ; water heavy, requiring steam-pumping power. The following strata were passed through :—

40 feet concretionary or pisolitic ironstone.
90 feet bouldery basalt.
6 inches fine white drift sand.
2½ feet coarse water-worn wash with coarse water-worn black tin.
Soft granite bedrock dipping north-west.

United Deep Lead. M.L.'s 549, 263, 523, Parish Clive, County Gough, 2¼ miles south-east of Gilgai.

Discovered about 1879 by an Inverell syndicate, who sank 135 feet through decomposed basalt in M.L. 549. A small quantity of coarse water-worn wash, carrying fine water-worn black tin ore, was found amongst granite boulders. Water in considerable quantity was encountered.

The Watkin's Tin Mining Company, registered in Victoria in July, 1902 ; capital £4,000, in 4,000 shares at 20s ; sank several shafts in M.L. 523. In the first a thin seam of rich wash was struck at 140 feet, dipping gently west. A second shaft, 20 chains west, bottomed at 130½ feet, passing through the following strata :—

25 feet ironstone and basalt soil.
100 feet decomposed basalt.
5 feet fine sandy drift
6 inches water-worn wash with some angular stones, carrying fine water-worn black tin ore.

Two shafts were then sunk in an eastern direction, the deepest (under aid from the Prospecting Vote) bottoming at 142 feet, on to 2 or 3 feet of drift and without wash, the bedrock dipping gently west. Much water and drift and encountered in a western drive from the latter caused abandonment in 905. Water made at the rate of 3,000 gallons per hour. About 40 tons of in ore are reported to have been obtained by the Watkins Company.

Victoria Lead, commencing near the centre of the west boundary of portion 268, Parish Swinton, County Hardinge, and trending westerly ; about ½ miles north-west of Tingha.

Discovered about 1883. Opened by shafts 105 feet deep. Particulars of workings and yield not known. Tin ore reported to have been mostly medium grained and water-worn.

Walmsley's Lead (also known as Victor lead), 3½ miles south-east of Gilgai, between South's Gully and Ponds Creek, Parish Clive, County Gough.

Discovered about 1880, by McCloskie, and afterwards worked by a company. Average depth of sinking, 40 feet through basalt soil and

decomposed basalt. The washdirt averaged 18 inches in thickness, and yielded an average of 40 lb. of fine water-worn black tin ore per load. Abandoned.

Warland's Lead, alongside Tingha–Guyra road, Parish Swinton, County Hardinge. Trending south-westerly and joining Chinaman's Lead near the road.

Discovered by Messrs. Warland and Sons in 1873, and worked by them for about a year. Practically idle since. Sinking averaged about 85 feet, exposing the following section :—

5 feet basalt clay and granite sand.
80 feet decomposed basalt.
1 foot white sand (no tin).
1 foot coarse water-worn wash.
Soft granite bedrock.

The wash is reported to have yielded 40 to 200 lb. of coarse water-worn tin ore to the load, a total of 40 tons being obtained.

Wetzler's Claim, Portion 608, Parish Clive, County Gough, $2\frac{1}{4}$ miles south-south-east of Gilgai.

Operations begun by J. Wetzler in 1895, still carried on by him. Several shafts, from 74 to 148 feet, have been sunk. The 148-foot shaft passed through the following strata :—

40 feet basalt soil and ironstone.
88 feet decomposed basalt.
16 feet sandy drift.
4 feet wash-dirt, averaging 30 lb. tin ore per load.
Hard granite bedrock.

Operations ceased in this shaft owing to want of steam power to cope with water.

Near the south-west corner of the portion a shaft was bottomed on granite at 74 feet, under aid from the Prospecting Vote, it was continued to 102, in soft granite, then driven in direction of dip, the latter proved too great to enable the water difficulty to be overcome. A new shaft commenced, to intersect lead at lowest level.

Wheal Edith Tin-mining Company.—A considerable area was secured in 1887, at Newstead, by the abovenamed company, viz., Portions 74 and 75, M.L.s 4 and 70, Parish Anderson, County Gough. A pumping plant was installed with ground sluices. About 10 tons of tin ore are reported to have been recovered from surfacing ; and 20 from a short lead, which was worked by shafts ranging from 60 to 200 feet in depth. The wash in the lead, varied from 2 to 2 feet 6 inches in thickness.

This company also sank a shaft in Portion 70, in greisen carrying a little tin and traces of carbonate of copper.

Wheeler's Gully, near south boundary of Portion 27, Parish Swinton, County Hardinge. Average depth of sinking, 8 to 10 feet in granite sand with some clay. Washdirt mostly angular, varying in thickness from 4 to 6 inches ; resting on hard granite bedrock. Yield up to 2 cwt. of tin ore per load. Insufficiency of water hampers operations.

White's Lead, near south boundary of Sp.L. 96–1 (McCrohon's Paddock) $1\frac{3}{4}$ mile south-south-east of Tingha, Parish Cope's Creek, County Hardinge.

Discovered about 1889 by White. Sinking is through decomposed vesicular basalt. Width of channel, about 2 chains. Wash consists of large angular pieces of quartz and rock crystal, tourmaline (resembling Long Gully schorl) "grass-stones," *i.e.*, clear quartz with acicular crystals of rutile ; highly

polished small stones, locally known as "bean" stones. Two or three small diamonds were obtained. The nature of the wash indicates derivation from a pre-existing diamantiferous lead.

This lead was very productive.

(*c*)—Tingha–Inverell

Lodes.

Ah Jack and Whiteman's Lode.—2 miles N.E. of Tingha; on ridge west of Herding Yard Gully, Parish Swinton, County Hardinge.

Discovered by J. Whiteman in 1894, who abandoned it after a few months owing to inability to cope with water. Worked for a few months by Chinese then abandoned for about twelve years. Re-opened by J. Whiteman and R. Partridge for about a year, during which they sank 20 feet and drove 23 feet. Subsequently worked for nine months by Whiteman and Ah Jack, and then taken on tribute by the present holders, Messrs. Fuller and Ryan.

The lode strikes N.E. in hard granite, thickness 2 to 8 inches; veinstone-quartz with coarse crystallized tinstone disseminated through it.

Opened by two shafts 53 feet apart, sunk 23 and 45 feet respectively; the shallower being driven 48 feet along the vein. About 5 tons of tinstone obtained to end of 1909.

Albion Lode.—C. S. Wilkinson, in 1875, described this occurrence in the following terms*:—

> "Fine crystals of quartz from Albion Tin Mine, Cope's Creek. These crystals are studded on the outside, as well as within, with black crystals of cassiterite, suggesting that the tin and silica were held in solution, and that they both crystallized therefrom at the same time.
>
> "About 2 miles N.E. from Captain Swinton's station are several small tin lodes, associated with veins of quartz and eurite, and traversing in an E.N.E. direction, soft red granite.
>
> "Other similar small lodes occur in various parts of the Cope's Creek district."

Allen's Lode.—Situated in the Jealousy Lead about one mile west of Stannifer.

Discovered by James Allen about 1893, and worked by him for about two years.

Strike N. and S.; vertical. Vein material consists of about 3 inches of white quartz at the north end, and the same thickness of felspar at the south, occurs with fairly well marked walls in soft granite. Found under about 14 feet of basalt soil. Opened to a depth of 50 feet in places, and for a considerable distance along the strike. About 20 tons of coarse reddish tinstone were obtained from it. This reef probably shed some of the tin worked in the Jealousy Lead which crosses it.

Auburn Vale Tin and Mineral Prospecting Co. (Limited), (*See* Leviathan).

Baalgammon Lode.—On north side of Baalgammon Lead, Parish Herbert, County Gough. On north side of Tingha–Stannifer Road.

Discovered by Stormer Bros. about 1886, and worked by them for a few months. Strike E. and W. in granite. Width averaged 1 foot. Veinstone-quartz with large lumps of solid tinstone.

Bathurst Lode.—About 4 chains from N.W. corner of Portion 70, Parish Anderson, County Gough. Strike N. 30° E. Opened by shaft to 40 feet in 1887; a little rich ore obtained in shaft and drive of 30 feet.

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* Mines and Minerals N. S. Wales, 1875, p. 83.

About 4 tons of the lodestuff are reported to have been treated at the Stannifer–Bischoff Battery on Boney Gully, but the result is not known. The gangue consists of greisen with a little quartz.

Beauchamp's Lode.—In M.L. 525, Parish Mayo, County Hardinge, 1¾ miles east of Howell.

Discovered about 1907. Strike N.W.; vertical. Reported as a "blow," 20 feet wide; diminished to 1 foot wide at 30 feet from surface. Vein material quartz and felspar, in slightly altered granite; some coarse tin present. About 1½ tons fine black tin obtained from it.

Big Mother Lode.—In M.L. 349, Parish Swinton, County Hardinge, near M.Ls. 349 and 538. About one mile from Tingha on Inverell-road.

Discovered by A. Orchard, senior, in 1901. Strike E. and W., vertical. Width 2 to 14 feet. Veinstone quartz and eurite, in granite. Opened by about 20 shafts from 14 to 86 feet in depth, close together. Three rich bunches of ore were struck extending for about 2 feet out from the ore channel. Vugs occurred containing crystallized quartz and lumps of tinstone from a few ounces to 2 lb. in weight.

The tinstone gave out in places for 10 or 12 feet along the lode, then made again. The rich bunches yielded about 50 per cent. tin; the average of the high grade being about 4 cwt. to the ton. The lower and larger portion yielded about 3 cwt. to the ton

The eurite decomposed rapidly on exposure, advantage being thus obtained in treatment. Sinking was also easy on this account. Water was slight, amounting to about 200 gallons per day.

About 70 tons of tin are reported to have been taken out of this lode; the separation of the tinstone being effected by crushing on the "bucking stone," followed by pulverisation between 8-inch steel rollers worked by two men.

Prospecting results along the western strike were not sufficiently encouraging for further effort in that direction.

Billy Barlow Lodes.—In M.L. 404, Parish Cope's Creek, County Hardinge, ¾ of a mile west of Single's Gully.

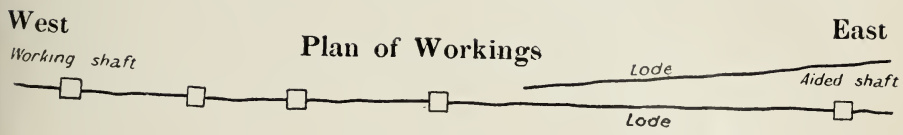
Discovered in 1891 by C. W. Little. Strike east and west, vertical; width from 1 inch to 4 feet. Veinstone crystallized quartz with coarse tinstone. Four tons are reported to have been obtained by the discoverer, who then disposed of it to a Victorian syndicate working the Federal and Reeve's Lodes. The latter abandoned the site two years later, in consequence of the tin giving out in places—and reported water difficulty.

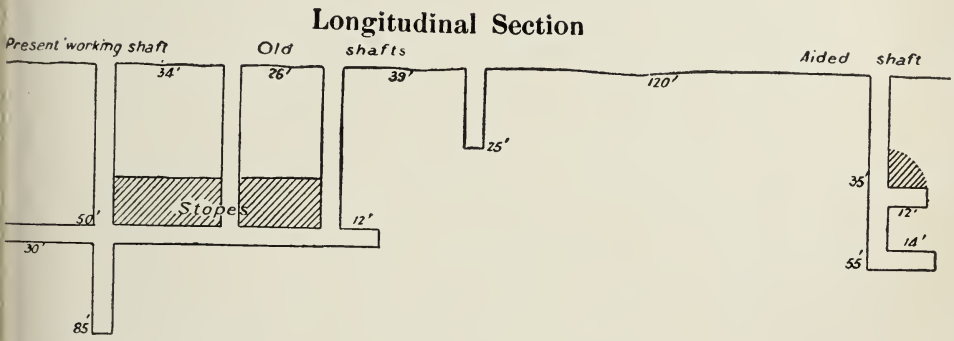
Of several shafts sunk on the line the deepest was 76 feet.

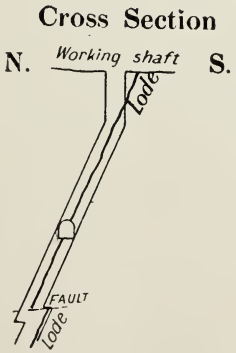
On the south-west another lode was discovered, and followed in an incline shaft for 100 feet, the vertical depth being 50 feet. Two tons of tinstone were obtained from it by Messrs. Little, about 1899. The vein averaged 3 to 4 inches in thickness, consisting chiefly of felspar. Sinking was hard and dry.

Binghi or Binghe.—About 40 chains west of Murray's Water, Parish Darby, County Hardinge, near Tingha. Discovered about 1883. Strike east and west, dip north at 65°. Thickness from 2½ to 15 inches—solid tinstone in places. Deepest shaft in March, 1909—75 feet, length of shoot worked about 80 feet. Shaft sunk 55 feet under aid 160 feet from east end of present workings, but little tin obtained. From surface indications it would appear that the east end of reef has been faulted about 13 feet to the north, or a new reef junctions at this point. Slight displacements (step faulting) of the ore shoot have also taken place in the present workings between 75 feet and 85 feet, the amount of throw being 2 feet 6 inches at 75 feet.

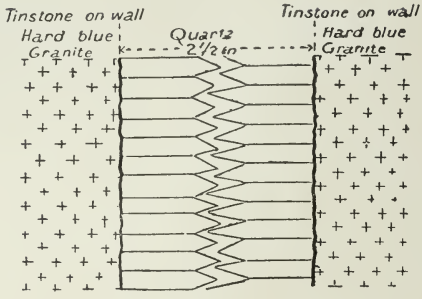
Binghi (or Binghe) Tin Lode, near Murray's Water, Parish Darby, County Hardinge.



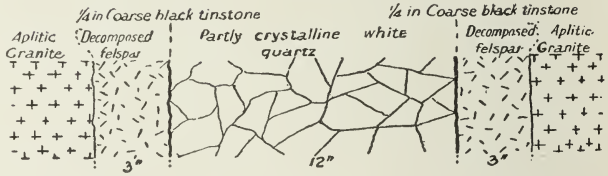




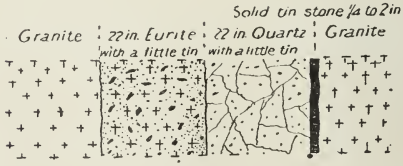
Section across Bismarck Lode, 4½ miles east of Tingha, Parish Cope's Creek, County Hardinge.



Section across Boundary Lode, M.L. 384, Parish Swinton, County Hardinge. (See page 204.)



Section across "Big Mother Lode" in M.L. 349, Parish Swinton, County Hardinge about 1 mile from Tingha. (See page 202.)



The lode averages about 4 inches in width, and consists mainly of tinstone in quartz and felspar; in places the tinstone being solid in the channel. Sinking so far is dry and soft.

At 85 feet the lode is 3 inches wide and fairly solid tinstone. The mine is held and worked by W. Kiehne and party, the lodestuff being crushed by by small horse-power mill. About 44 tons of dressed tinstone were raised by the party to March, 1909. At the end of 1909 the shaft had been deepened to 120 feet. The output for the year being 9 tons.

About 25 chains south 20° east from the working shaft, a parallel lode occurs of a thickness of 1 to 2 inches. The tinstone has been deposited along a joint plane in "Tingha" granite. Dip northerly at a steep angle.

Birtleson's Pipe (also known as Cox's, or Pitkin's Pipe), Parish Cope's Creek, County Hardinge; about 4 miles S.S.E. of Tingha.

Discovered by Messrs. Birtleson and Pitkin, about 1894, and worked by them for some months, during which they obtained 8 tons of fine-grained black tin.

It was further developed, in 1907, by Messrs. Smith and Wilson for about three months, for a yield of 1 ton.

The ore occurs in the form of a pipe in fine-grained felspar gangue, nearly circular, and about 4 feet in diameter.

The first shaft followed the pipe 15 feet vertically, then 15 feet horizontally, and finally other 50 feet vertically.

A second shaft was sunk 50 feet vertically to meet the shoot, and at that depth a much smaller pipe was found, branching from the west side, and dipping east at a low angle. This pipe carried a little fine tin in the east end, but it gave out westerly.

The main pipe also appeared to give out, only hard unaltered granite being traceable below.

The tinstone occurs well disseminated in grains through the felspar rock.

Bischoff Lode. (See "Stannifer-Bischoff.")

Bismarck Lode.—Portion 216, Parish Cope's Creek, County Hardinge. At Red Hill, about 4½ miles east of Tingha, C. S. Wilkinson examined the lode and reported:—

> "A dyke of eurite granite, bearing E. 15° N., containing tin veins, had been discovered at the Bismarck Tin Mine, south of Cope's Creek.
>
> "The tin ore is associated with quartz veins, from a mere string to 3 inches thick, and traversing the dyke in various directions, forming a a sort of net-work of veins. The ore is usually crystallized in square prisms, lining the sides of the fissure, with the quartz filling the centre; sometimes, however, the whole vein makes into quartz, with separate tin crystals scattered through it."*

It is reported that this reef was discovered by Conrad Bowers, and worked by him at various times. Recently it was worked on tribute by Messrs. Whiteman and Ah Jack.

The tinstone is mostly crystalline, and jet black. The lode has been opened for about 190 yards along its course by shallow trenches in hard granite, the deepest 9 feet and 3 feet wide. About 5 tons of tinstone have been obtained to the end of 1909.

Black Angel Lode.—Eastern fall of Red Hill, Parish Cope's Creek, County Hardinge.

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* Mines and Minerals N. S. Wales, 1875, p. 83.

The Mining Registrar, in 1875, reported,—

> "That a tunnel has been driven into the centre of the hill (commonly known as Red Hill), and some eight or ten men are satisfactorily engaged in developing the mine. Yield about 1 ton per month."

Bolitho Mine. (See Simoni's.)

Boundary Lode.—M.L. 384, Parish Swinton, County Hardinge, 3½ miles N.N.E. of Tingha.

Discovered in 1872 by the Boundary Company, who sank 70 feet in fairly hard granite.

C. S. Wilkinson visited it in the year of discovery and reported :—

> "In the Boundary Tin Mine several quartz veins have been opened in ordinary ternary granite ; they strike E. 20° N., and the dip is nearly vertical. The quartz is coarsely crystalline, and the tin ore occurs in crystals scattered through it; also to a small extent through the encasing granite walls. One of the veins now about to be opened has a soft and more felspathic casing than the others." *

At a later date the same authority wrote :—

> "A vein of solid ore, 4 inches thick, has been opened in the Boundary Mine, fluor-spar occurs in this lode, and also a greenish-yellow steatitic clay."†

The Boundary Company opened the lode by a vertical shaft at the south west end. In this it averaged a foot in thickness, and consisted of brittle white quartz in part. The aplitic granite wall-rock was altered for about 15 inches on both sides of the reef. The sinking was dry and hard. (See plate.)

After operations had ceased for some years, Messrs. Walmsley and others carried out a considerable amount of trenching at the north-east end, to a depth of 14 feet, the vein averaging about a foot as in the Company's workings ; it here consisted of crystallized white quartz in part, with a little tin through the quartz, and narrow seams of ironstone. A shaft was then sunk 25 feet. Several small quartz veins were reported branching from the main lode at slight angles.

A large quartz reef appears to junction with the Boundary Lode a few chains north of the main shaft. About 10 chains from this point, J. Lock sank 50 feet on the big reef, about 1902. About 3 cwt. of tinstone was obtained, mostly from the outside of the quartz vein.

Bough-yard Gully Lode.—Between Tingha and Grove Station. Described by C. S. Wilkinson in the following terms :—

> "On the Bough-yard Gully, between Tingha and Grove Station, Messrs. Canning and Hulton have discovered a tin lode which differs from the lodes above described, in its having a northerly strike ; but this may be a local variation, as it occurs in a broad belt of euritic granite, in which it may have connection with other lodes.
>
> "Near the surface the lode is only a few inches thick, but it increases to a width of nearly 1 foot of almost pure tin ore, at a depth of about 30 feet, where it is broken by a fault or slide.

* Tin-bearing country, District of Inverell. Legislative Assembly Papers, 1873, 176-A, p. 2.
† Mines and Minerals N. S. Wales, 1875, p. 83.

"The ore has a loose granular texture, and sometimes occurs disseminated in grains through the encasing rock, which consists of a white eurite, much broken by joints. For a few inches on either side of the lode, the rock shows alternate vertical layers of quartz and felspar." *

Brennan's Lode.—M.L. 488, Parish Mayo, County Hardinge.

The principal lode discovered at the head of Two Mile Creek. Strike north-west. Opened by two shafts close together, one to a shallow depth only. The deepest shaft was sunk under aid from the Prospecting Vote.

The lode apparently consists of a joint in granite, after the character of the Stannum Lode, quartz being absent, the tinstone occurring with felspar. Width of channel reported to be 4 feet, with veins of rich tin ore (unable to examine workings). The cassiterite appears to be disseminated in grains in the wall rocks.

Brennan's Race, from Cope's Creek, about 5 miles in length, commands all the gullies and alluvials between the lode and Two Mile Creek.

Brickwood Lode.—In M.L. 388, Parish Swinton, County Hardinge, 2 miles north-east of Tingha, about 200 yards from Guyra-road.

Discovered by Dunbar about 1879, who obtained 22 tons of coarse tinstone from the north-east end. Strike north-east. Dip slight to north, but variable. Richest patches where variations occurred.

The south-west end was opened about 1894, and the main tin-bearing portion about 1901, when Messrs. Brickwood and Jones discovered the richest portion. From a shaft 53 feet deep, following a slight southerly underlay, the latter party obtained 48 tons of coarse black tinstone, in part crystallised.

The lode consists of white quartz, with soft granite walls. Sinking so far has been dry. In the last shaft a decomposed felspar vein, about 4 inches wide, was cut, carrying fine-grained tin oxide.

The average yield of the vein was 7 cwt. to the load. About 150 tons of tinstone have been obtained from a total length of 20 chains along the lode, on which nearly fifty shafts have been sunk.

Britannia Mine, Darby's Branch, near Tingha. C. S. Wilkinson, in 1872, reported :—

"At the Britannia Company's Mine, on Darby's Branch Creek, above its junction with Cope's Creek, a quartz vein, 8 inches thick, traverses granite in the same direction as the joints—east 20° north. It contains iron pyrites, galena, and green carbonate of copper."

S. W. Moore reported, in 1876, that a shaft had been sunk 45 feet on the lode, and driven east 50 feet from that level. It averaged 6 to 9 inches in width, with a vein of tin about 1 inch thick running through it.†

Butchart's Lode, near south boundary of Portions 165 and 166, Parish Swinton, County Hardinge, 2 miles north of Tingha. In 1872 C. S. Wilkinson recorded its discovery by Messrs. Martin and Irwin, and described it as a "dyke about 20 feet wide of white felspathic eurite in granite of a similar character ; its direction is E. 5° N., and a few thin seams of tin ore and quartz run through it. The surface soil on the side of the hill below the dyke is now being sluiced, and yields from 20 to 40 lb. of tin ore to the load."‡

Working the alluvial tin to the foot of the hill led the discovery of its source in the granite.

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* Tin-bearing country, New England. Legislative Assembly Papers, 181—A, 1873, p. 7.
† Ann. Rept. Dept. Mines for 1876, p. 69. ‡ Legislative Assembly Papers, 176—A, 1873, p. 2.

C. S. Wilkinson also recorded another discovery :—

> "About 1 mile to the north-east (from Butchart's Lode J. E. C.) Messrs. Martin and Irwin, have another block of land adjoining the Inverell Company there, in the surface-soil at the head of a gully, they have found lumps of solid tin ore, 3 or more inches thick ; these are not water-worn, and must therefore, have been derived from a lode not far distant, in prospecting for which several thin lodes of tin ore have been found ; also a quartz vein 4 inches thick, with crystals of tin ore scattered through it ; their course is about E. 15° N." (*Ibid.*)

The Butchart lode was acquired in 1879 by the Union Tin Mining Company, Tingha, who erected a 5-head battery at the junction of Copes and Herding Yard Creeks.*

W. H. J. Slee reported in 1880 a trial crushing of 8 tons, which yielded 2 tons 2½ cwt. of probably 73 per cent. tinstone.†

The Union Company continued operations for about four years. The richest portion of the lode was about 12 feet wide, but thin seams of tinstone extended beyond this limit. In one shaft sunk for the Company to a depth of nearly 100 feet, or 70 feet below the tunnel level, in hard aplitic granite, a vug was cut at 70 feet, containing native copper, and crystallized tinstone.

After practical abandonment for fifteen years, the lode was taken up in 1894 by M. Partridge, and has been worked intermittently by him ever since. The total amount of tin thus obtained is stated at 70 tons, mostly coarse black tin occuring in thin parallel seams having a general E. and W. to N.E.–S.W. trend, and vertical dip. The open workings extend for about 400 feet, and to a depth of about 30 feet at deepest, and a width of 8 feet or more. The total width of tin-impregnated aplite is about 50 or 60 feet. Mostly the seams strike with the aplite, but others cut across, forming a "stock-work." The country is extremely hard and the tin "frozen" on, to use a mining colloquialism.

Tin values vary very considerably in depth being alternately rich and nearly barren. In the latter portions the veins persist, but the tin is replaced by quartz. The total length of lode traceable is about 300 yards. There is no marked difference between the granite traversed by the veins and the non-stanniferous country adjacent.

Cadogan's Lodes, also known as the "Huel Cliff" Mine, (Por. 8), P.M.L. 3, Parish Auburn Vale, County Hardinge.

Discovered about 1904 by W. Day. Taken up by A. L. Cadogan in 1908, and worked for about six months.

Three parallel veins occur about 40 feet apart, striking north-west. The east vein has a width of 2 feet, the centre and west veins being each about 1 foot. The veinstone is largely arsenical pyrites in a more or less micaceous granite, a little copper carbonate and sulphide also occur. On the 2 feet a shaft has been sunk at the north-west end to a depth of 80 feet ; and two others at the S.E. end to 40 and 50 feet. The sinking was in acid granite. The western lode was opened by two shafts 40 and 70 feet deep.

A little water made in the deepest shafts. The ore raised is reported to grade up to 4 per cent. One of the lodes, at least, is seen crossing the Auburn Vale–Inverell road on the north-west strike.

A trace of molybdenite occurs in a parallel quartz vein on the west in the same portion.

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* Ann. Rept. Dept. Mines for 1879, p. 134. † *Ibid.* 1880, p. 229.

Cains Lode.—Near south-west corner M.L. 61, Parish Herbert, County, Gough, at the south-western foot of Topper's Mountain, about 5 miles north of Tingha.

Discovered by John Cain in 1872; worked by him, later by J. Lock, and subsequently by Chinese fossickers.

Strike N.E., dip. N.W. Average width about 1 foot, of partly crystallized ferruginous and white quartz in granite, with a little tinstone on each side of the quartz. Only a small amount of work done.

Carney's Lode.—Adjoining the north boundary of Portions 208 and 209, Parish Swinton, County Hardinge, 3 miles N.N.W of Tingha, near the Brickwood Lead.

Discovered by D. G. Staschen in 1873, but worked by others until about 1889, since then little prospecting has been done.

Numerous shafts, averaging about 20 feet in depth, and some open trenching, and a little driving constitute the extent of proving. The tin occurred in narrow parallel seams of solid cassiterite, striking from east and west, to east 10° north in soft granite.

Chinaman's Lode, in bed of Chain of Ponds, or Irwin's Gully, just below Bowden's old dredge site.

Discovered in 1909 whilst working alluvial. Strike, east and west across bed of creek. Thickness, 1 to 12 inches, proved for about 40 feet in length. Almost solid cassiterite in parts. About 2 tons extracted.

Christie and Wilson's Lode.—On south fall of Tingha Dividing Range, on King Mountain, also known as "The Pine Mountain," near head of Bull's Camp Gully, 5 miles E.S.E. of Tingha, Parish Cope's Creek, County Hardinge.

Discovered about 1894 by the prospectors it is named after. Strike, approximately, east and west. Thickness, 3 to 4 inches. Appears to give out to the east. Opened by trenching and drives for a distant of 75 feet. in hard rock. Tinstone, medium to fine-grained; about 2 tons obtained. Abandoned about 1899.

Collas' Lode, on south side of Slurry Gully, 1½ miles north-west of Tingha, Parish Swinton, County Hardinge.

Discovered by E. L. B. Collas about the end of 1908. Strike, E. 10° N.; dip, 1 in 4 to N. 10° W. Varies in width from a thread to 1 foot. Five shafts—25 to 40 feet deep—sunk along the line in moderately easy ground; no water so far. Vein consists of partially decomposed felspar, with white quartz. Three-quarters of a ton of tinstone obtained to about middle of 1909.

Cooper and Barnett's Lode, 150 yards south-east of Brickwood Lode, 2 miles north-east of Tingha, Parish Swinton, County Hardinge. Strike, north-east; dip, vertical. Vein, quartz and felspar, in hard granite. No defined walls near surface, but well defined at 40 feet level.

Discovered by Messrs. Cooper and Barnett in 1893. Worked for about one year. Shaft sunk 60 feet, and a little driving along the lode. Below 40 feet explosives required. Several tons of coarse, black tinstone obtained.

Cope's Creek Tin-field.—In 1872, C. S. Wilkinson, then Licensed Surveyor, was engaged surveying at Tingha, and paid great attention to the rapidly developing tin-field of Cope's Creek, as it was then called. Writing of the field, he stated:—

> "The tin lodes are associated with the numerous veins and joints, which traverse the granite in a direction between E. 5° N. and N.E.; the largest lodes yet discovered occur with quartz veins in felspathic eurite dykes." *

* Tin-bearing country, district of Inverell. Legislative Assembly Papers, 176—A, 1873, p.

In a further report (ordered to be printed by the Legislative Assembly, 15th January, 1873), he gave fuller expression to his views :—

"The granite formation varies much in character, from the simple binary combination of quartz and felspar to that with mica added; then these three components vary in colour and proportion even within the space of a few yards. Eastward of Captain Swinton's station, it becomes porphyritic, and assumes a white, speckled appearance, from the numerous enclosed crystals (about 1 inch in size) of white felspar (orthoclase). In many places cavities occur in the granite. These are frequently lined with beautiful crystals of smoky quartz; small nests of radiating crystals of black tourmaline (schorl) are also common in the rock."

"Thin veins of quartz and vertical joints traverse the granite in a northerly direction; these have been "faulted" in a remarkable manner by another set of joints running E. 5° N. and N.E.; the faults or slips are on a small scale, as perfect as those commonly seen in the carboniferous and other sedimentary strata. They are well shown in the granite at the Rex Tin Mining Company's ground in Middle Creek, or the Cope–Hardinge Mine, near Tiengah; and again about 8 miles lower down Cope's Creek. Indeed, throughout the whole granite area I now describe, the system of joints and veins prevails, and in some parts so regularly is the granite split up or cleaved by these vertical joints that it has the appearance of a stratified formation, with the strata turned up on edge.

"I have paid particular attention to this system of joints and veins, for at present no minerals of value have been found in those having a *meridional* direction, while, with but one or two exceptions, it is only in the veins and joints bearing E. 5° N. to N.E. (which are evidently of more recent origin) that the tin lodes have been found in the vicinity of Cope's Creek."

Coronation Lode.—Near Oliver's Gully, one of the heads of the Two-mile Creek, 4 miles north-north-west of Howell, Parish Mayo, County Hardinge. Discovered by F. Huxley about 1900. Strike N. 11° W., vertical to 60 feet, then 1 in 5 to east. The lode is from about 3 inches to 4 feet wide, of brecciated felsitic rock, with quartz veins and a little tin. Opened by shaft to a depth of 100 feet, with assistance from Prospecting Vote. At 50 feet the shaft passed into soft kaolinized veinstuff. Tin-bearing portion varies up to 9 inches in thickness. 2 tons of coarse tin ore are reported to have been obtained from the shaft. Southerly from the shaft, the reef pinches where visible. Numerous parallel thin veins occur on the east side. A cross vein of bluish quartz and felspar is reported to yield a little tin in the rubble, but has not been opened.

Northerly along the strike of the lode, a tunnel has been commenced, to drain the shaft. The prospects of this mine as a tin producer are not bright. The brecciated character of the filling denotes considerable fracturing, which may indicated deep-seated fissuring; but the tin contents are very light.

Cox's Pipe.—On east side of Sutherland's Water, 1½ miles from Tingha. Opened about 1905. Yielded £4 worth of tin per foot for 23 feet. Tin still in bottom in lesser quantity, in hard shooting ground.

The following figures and description are by E. C. Andrews, B.A., Geological Surveyor :—*

Fig. 8. (A).—Plan of tin "pipe" in granites, Sutherland's Water, one and a half miles west of Tingha.

a Unaltered hornblendic granite.
b Granite and ferromagnesian constituents changing to chlorite and sericite.
c More advanced phase of alteration. White felspar and sericite developing.
d White felspar, drusy by partial removal of sericite. Small tin percentages.
e Change to solid tinstone.
f and *g* Intersecting joints, determining "pipe."
h Great alteration of country to felspar and sericite along joint.

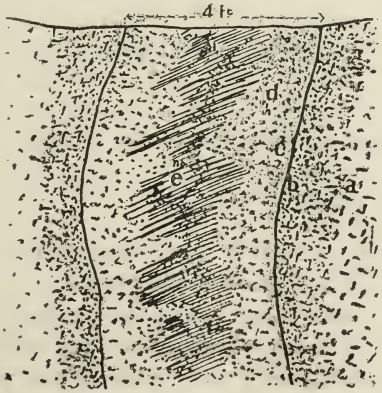

Fig.8. (B).—Section of "pipe."

* Records Geol. Survey N. S. Wales, 1907, viii., p. 240.

"The 'pipe' is subcircular in horizontal section, with a diameter of 4 feet, and having an average inclination of 80 degrees to the horizon. It is about 30 feet deep, is slightly tortuous in course, and is slightly differentiated from the surrounding country by a more or less defined surface, the presence of which facilitates mining operations. Traced along the greater diameter the 'pipe' assumes a blunt-wedge shape, and passes into a mere joint less than one-twentieth of an inch in width. This joint also may be seen passing through the apex of the wedge into the pipe [*f* and *h*, Fig. 1A.] The trace of another joint is seen at *g*. At *a* is seen the unaltered hornblendic granite-porphyry; at *b* chloritisation and sericitisation of the ferromagnesian constituents has taken place; at *c* the ferromagnesian element has been altogether replaced by sericite; while at *d* the mass is a drusy, white-banded felspar, the sericite being replaced by felspar. The centre of the mass *e* is composed of solid amorphous felspar, with abundant tinstone.

"A study of the 'pipe' and the joints shows that the ore deposit is a replacement of granite by solutions and gases rising along the intersecting joints. The water (and gases) acted from an incredibly small core much as follows:—The hornblende and biotite of the granite country were altered to green products in which traces of sericitisation are noticeable. A further change was marked by the development of sericite and allied material. The felspars were subsequently altered to smaller grains of striated white felspar, and the sericitic material at the same time was in great measure leached out and replaced by similar felspar so as to give a drusy appearance to the resulting product. With this, small percentages of tinstone are incorporated. The quartz was now also replacsd by felspar, and the more central masses became changed gradually to solid grey felspar, heavily charged with tinstone.

"Other pipes, dykes, and veins evidence equally wonderful changes of country. In one instance a eurite dyke is accompanied by a mass of pegmatite, also of quartz with a small percentage of felspar and sericite, and in this the tinstone occurs. In another instance, quartz and sericite accompany a eurite dyke, and through the whole, eurite and quartz, the tinstone is developed. In other 'pipes' an abundance of tufted yellow sericite is in evidence.

'Pipes' of this type may be permanent for considerable depths, seeing that the feeding mass is younger than the country and is fairly deeply seated. Limits, however, are set by the persistence of both joint sets. Should one joint, for instance, admit the tin, while the other contains some reagent necessary for country replacement, then the 'pipe' formation would cease where this joint died out or pinched."

Cox's Murray's Water Lode.—300 yards west of the Kershaw Dredge site in 1909), 3 miles west of Tingha, Parish Darby, County Hardinge.

Discovered about 1893 by F. and H. Cox, and Sam Ah Pat; who worked it for about six months, obtaining 10 tons of (mostly) coarse tinstone. Strike E. and W., dip vertical. Width from 6 to 18 inches. Veinstone varies in composition from felspar to quartz. The tin ore being fine-grained in the former and coarse in the latter. Vugs occurred at intervals lined with crystallized quartz with minute crystals of cassiterite investing the crystal faces. The veinstone appears somewhat in the form of lenses a few feet in length. The principal operations of the discoverers were confined to trenching about 12 feet deep along the lode for a length of 100 feet. The outcrop disclosed a 6-inch vein of solid tinstone projecting; lumps up to 100 lb. weight being obtained.

On completion of the trenching the lode was abandoned until 1909, when Messrs. Wilson and Shepherd took possession, and sank to the 25-feet level, and intend continuing to 60 feet. Sinking is dry, but the granite requires explosives.

Cox's Lode.—About 200 yards east of Sutherland's Water, and $1\frac{3}{4}$ miles south-west of Tingha, Parish Darby, County Hardinge.

Discovered by J. Cox about 1897, and worked for a few months, then sold to Ah Patt and party, by whom it was worked for about a year, and intermittently since by others. No work since 1904.

Strike east and west; dip slight to north; thickness of lode about 2 feet, with $2\frac{1}{2}$ to 6 inches of solid tinstone in centre; veinstone quartz.

Opened by shafts for a length of 80 feet, the deepest being 35, 55, and 58 feet respectively in soft granite; very wet at west end, but dry and hard at east.

About 12 tons of medium-grained tinstone were obtained from it.

Cricket Ground Lode.—In Litchfield's private land, east of cemetery, and adjoining south boundary of Tingha Cricket Ground, Parish Darby, County Hardinge.

Discovered by R. Duncan about 1895, and worked by him and others for eighteen months. Most of the following particulars were supplied by the discoverer.

Strike east and west. dip vertical for 40 feet, where the lode was faulted in a northerly direction for 3 feet; from this point the dip was slightly to the north. Sinking was soft to 80 feet, thence gradually hardening and requiring explosives. Thickness of lode varied from about 4 inches near surface, to 3 feet in places with descent, constituting a series of lenses. The deepest shafts in the reef are 30, 45, and 106 feet respectively, the latter at the west end. No water difficulty encountered in sinking.

The vein material consisted of soft felspar and kaolin for 15 feet, then soft felspar, continuing soft even in hard granite at 90-feet level. The vein walls are well-defined, though altered for a width of 8 inches on either side. In the centre a seam (up to 1 inch) of solid tinstone occurred. At the 40-feet level at the west end a $\frac{1}{2}$-inch vein of solid tinstone, with a little felspar casing. was traced 4 feet north of the main vein, when a "pipe" was found, of circular form, and a diameter of 5 feet. This "pipe" extended to the surface and contained similar veinstone to the main lode. (See Fig. facing p. 254.)

The pipe was practically vertical, but apparently did not continue far below the point of intersection.

Aid granted from Prospecting Vote in 1901 to continue sinking from 84 feet to 184 feet.

Total depth reached, 102½ feet; vug reported, 1 foot wide at bottom.

Three years after first abandonment it was again worked for a time by Messrs. W. Duncan, jun., and others, but has not been opened since 1898.

In all, about 15 tons of mainly coarse black tin were obtained.

Davis' Lodes.—Quarter mile east of Murray's Water, 3 miles south-east of Tingha, Parish Darby, County Hardinge.

Discovered in 1885 by Davis Brothers, and worked by them for three years. Strike, east and west, dip, vertical; vein-stone, mainly felspar, with narrow quartz veins, carrying fine-grained tinstone. Sinking in soft granite, but dry. Thirty tons of tin ore reported to have been raised from the north shaft (50 ft.) and its drives, and 5 tons from a parallel vein 20 ft. south, which was opened by shaft to 40 ft. Vein similar to the first described.

Doolin's Lode.—Three miles north-east of Howell, near Two-Mile Creek, Parish Mayo, County Hardinge.

Discovered by E. Doolin about 1906, and worked intermittently for two years. Strike, north-west, vertical; width, from 3 to 16 in.; vein-stone, felspar in granite, carrying coarse tinstone, up to 7½ lb. weight. Opened by shallow shafts and a little trenching for a length of 240 ft.. Sinking, very wet; 8 tons of tinstone reported to have been obtained.

Elsmore Hill.—Parish Anderson, County Gough.

The site of first discovery (in 1871) of payable tin ore in New South Wales (*vide* p. 15); was visited by G. H. F. Ulrich, F.G.S., in 1872, who contributed a paper to the Geological Society, read November 6th, 1872*, from which the following extracts are taken :—

> "Perhaps the richest mining area yet discovered is that of the Elsmore Company, situated about 12 miles east of the township of Inverell. It lies on the north-west side of the Macintyre River, and includes a granite range about 250 ft. in height and nearly 2 miles in length, dipping on all sides save that towards the river, beyond which the rock extends a considerable distance beneath basalt. The granite is micaceous and rendered porphyritic by crystals of white orthoclase, which frequently reach several inches in size; bluish-grey oligoclase is also, though sparingly, associated. It is traversed by quartz veins several inches to above a foot in thickness, which contain cassiterite in fine druses, seams, and solitary crystals. Portions of these veins are highly micaceous, and represent in fact the rock called "Greisen," characteristic of the tin-ore districts of Saxony and Bohemia. Of far greater importance, however, than these veins are dykes of a softer kind of granite, which consists perhaps for 75 per cent. of its mass of small scaly greenish mica, and the remainder of felspar, quartz being but very rarely observable. Through these micaceous dykes cassiterite is not only well distributed in implanted crystals from the size of a pin's head to about that of a pea, but it occurs also in irregular veins of several inches thickness, and in nests and bunches yielding lumps of nearly pure ore up to above 50 lb. in weight. Part of the mass of one of these dykes forms a regular breccia of mica and imperfectly crystallised tin ore cemented by hydrous oxide of iron.
>
> "The actual number of such dykes traversing the granite range is not known as yet. I saw six of them, each several feet in thickness;

* Quart. Journ. Geol. Soc., 1872, xxix, pp. 5–11.

but there can be no doubt that more will be found when the ground is more minutely prospected than has hitherto been the case. . . . . After seeing the place and being informed that throughout the large area belonging to other mining companies on the opposite side of the river similar stanniferous quartz veins and dykes had been discovered, the conclusion I came to is that the granite mass, as a whole, represents one of the so-called "stocks" or "stockworks" similar to those of Saxony and Bohemia, but of incomparably greater size and richness.

"As far as could be seen in the small workings of the Elsmore Company on several of the quartz veins and dykes, the dip of the latter is rather steep and the walls pretty well defined, but thickness irregular; thin flat veins join in occasionally. The deepest shaft sunk on one of the quartz veins was about 60 ft., and the tin ore occurred in irregular thin veins, and often beautifully crystallised in druse cavities. On examining the spoil-heap round the shaft, I discovered lumps of a ferruginous clayey substance full of thin light-green and yellow hexagonal prisms of beryl, associated with larger quartz crystals. I also observed beryl on crystallized cassiterite specimens, its fragile prisms, generally not thicker than a stout pin, and up to an inch in length, interlaced between the tin-ore crystals. Of other minerals, I found in the stuff excavated from one of the dykes frequently patches of arsenical pyrites, and more rarely grains of copper pyrites, the former generally containing imbedded crystals of tin ore. From another part of the ground the manager preserved a large piece of fine rock-crystal, which also enclosed small crystals of tin ore. Wolfram has been found at several places forming nests in the granite, but not in association with cassiterite."

C. S. Wilkinson, after quoting Ulrich's description *in extenso,* records a crushing of over 100 tons of the micaceous rock described, which yielded almost 1 per cent. of ore; and from the quartz reefs at a depth of about 80 feet, a yield of 8 to 10 per cent. of tin ore is recorded.*

Federal Lode.—Portion 178, Parish Darby, County Hardinge, 3½ miles south-west of Tingha, between Sutherland's and Murray's Waters.

Discovered by W. Duncan, about 1884, and worked by him for about one year, during which he sank 30 feet. The tin-bearing lodestuff occurs more in the form of a "pipe" than a reef; being oval section. At surface its diameter was about 5 feet, but soon diminished with depth. The lode material is chiefly felspar—somewhat decomposed—in hard blue granite. The strike is E. 5 N.

Duncan extracted about 85 tons of tin ore, and then sold the mine. Eventually a company was formed with large capital. A new shaft was sunk 40 feet west of Duncan's shaft, and cut the pipe at 96 feet. The shaft was continued vertically to 210 feet, having passed through the lode. At 210 feet the granite is reported to have become soft, and much water made—the first encountered—operations then ceased (1892). The shaft was three chambered and timbered with 2 inch sawn timber; it was sunk under aid from the Prospecting Vote. The country consists of biotite granite (the Tingha), and is intruded by acid granite, described by G. W. Card as consisting of much orthoclase, with quartz, a little plagioclase, and a very little biotite and sphene [7948.]

* Mines and Minerals N. S. Wales, 1875, p. 85.

Fisher and party's, near Coronation Reef, Parish Mayo, County Hardinge. Opened for a few feet only. Strike N. 20° W. Quartz veins in hard granite. Greatest width about 1 foot; splits into strings. Tin ore leanly distributed in the quartz. Vugs lined with quartz crystals occur.

Goldspink's Lode.—About 30 chains north of Middle Creek Crossing, on Inverell-Armidale Road; 6 miles north-east of Stannifer, Parish Herbert, County Gough.

Discovered by George Stormer about 1902, who extracted about 2 cwt. of tinstone. Strike north east, vertical in hard aplitic granite. A net-work of thin quartz veins in felsitic material, of greater width than prospecting shaft. A rich bunch of ore obtained by Goldspink and Roberts in 1909, at surface. At 33 feet in depth the tin ore became less and mixed with sulphide of copper and mispickel. About 22 cwt. of dressed tinstone despatched.

Grant's Lode.—Portion 1, Parish Anderson, County Gough, on south bank of Macintyre River, at Newstead. Opened by T. Grant about 1878, by an open cut 15 feet deep. Strike N. 50° E., width 3 to 6 feet. Lodestuff, greisen and quartz with a little fluorspar. Tin crystals occur in the greisen.

Hennessy's Lode.—Near head of Quart Pot Gully, 2½ miles E.N.E. of Howell, Parish Mayo, County Hardinge.

Discovered by E. Doolin about 1905, worked by J. M. Doolin for a few months. Subsequently taken up by T. Smith and party, who sank 30 feet, with aid from the prospecting vote.

Strike N.W. Dip apparently vertical; veinstone, quartz and felspar in very hard granite. Very narrow, of little value.

Hit or Miss Lode.—Head of Long Gully, a branch of Sutherland's Water, Parish Cope's Creek, County Hardinge.

Under the above name C. S. Wilkinson, in 1872, described some stanniferous veins, which may correspond with Reeve's Reef, or a neighbouring vein :—

> "On the Hit or Miss ground, at the head of Long Gully, a soft felspathic eurite dyke, about 2 feet wide, has been opened to a depth of 20 feet; its dip is vertical, and a lode of solid tin ore from 2 to 4 inches thick, follows down the centre of it. . . . . A few yards to the east a quartz reef crops out on the surface, apparently connected with this lode. For 200 or 300 yards from this lode several smaller lodes of tin ore, from ¼ to 1 inch thick, with thin quartz veins, have been disclosed by removing the surface soil, which is rich in small angular fragments of tin ore, evidently derived from these lodes. All the lodes strike about E. 20° N.
>
> "About a mile to the south-west, on the Wollumbi Company's land, a shaft has been sunk 25 feet in hard grey porphyritic granite, traversed by several narrow dykes of white eurite. In these, eleven thin seams (each about ¼ inch thick) of oxide of tin, in fine crystals, have been found in a width of about 5 feet. They all bear E.N.E.*

Hong Hay's "Pipe."—Near upper part of Moore Gully, a western branch of Sutherland's Water, near Hay's old sheep station, Fox's Mountain, Parish Darby, County Swinton.

Discovered by A. Hong Hay and W. Kim about 1896, and worked by them for six months, during which they obtained 20 tons of fine-grained tin ore. Near the surface lumps of tinstone, assaying 68 per cent. of tin, were obtained without dressing.

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* Tin-bearing country, district of Inverell. Legislative Assembly Papers, 176—A, 1873, p. 2.

The lode material consisted mainly of decomposed felspar and a little quartz. The top of the pipe was by far the richest portion, the tinstone decreasing with depth. Sinking was remarkably soft for the first 60 feet, and remained dry when followed to 90 feet. The main trend of the pipe was south-west; its form was roughly oval in section, in hard, fine-grained granite, with very little biotite, traversed by numerous master-joints striking east and west. In cross-section the pipe averaged from 6 feet x 3 feet to 6 feet x 4 feet. It inclined at a steep angle for the first 25 feet, thence practically vertical for 20 feet; again at the previous angle; and subsequently vertical to 90 feet—the lowest level attained.

Messrs. Smith and Wilson, in 1908, reopened the mine, after abandonment for a number of years. Work only continued for a few months, owing to decreasing yield and increasing hardness, explosives being necessary.

It is reported that a tin-bearing vein, with defined walls, made its appearance at the lowest level reached; it was opened up for 10 feet along its east and west course.

Howchin's Lode.—Near N.E. corner of M.L. 177, Parish Swinton, County Hardinge, 2 miles north-east of Tingha.

Discovered by Howchin about 1897, who worked it for a few months only. Strike N.E. in hard granite. Dip slight to north. Width from 3 inches to 12 inches. Veinstone, quartz. Shaft sunk 50 feet, and driven a few feet strike. Yield, 6 tons of coarse tinstone.

The same miner also opened a similar lode a short distance to the south-west about 1902, obtaining a small quantity of tin ore. Thought to be a continuation of the first lode on the south-west strike.

Howchin's Lode.—Sutherland's Water; adjoining the *Surprise Lode*, of which it may be a continuation. About $\frac{3}{4}$ mile west of the Tingha Racecourse, Parish Darby, County Hardinge.

Discovered and worked by Howchin and others, until about 1908. Strike E. and W. Dip nearly vertical. Opened by several shallow shafts and some trenches. Several tons of tin ore are stated to have been obtained from this lode. The cassiterite diminished with depth, and the rock became hard.

Hutchinson's Felspar Lode..—Near White's Lead, $2\frac{1}{2}$ miles south of Tingha, Parish Cope's Creek, County Hardinge.

Discovered by Hutchinson about 1907. This vein carries very little tin, but is remarkable for the symmetrical development of orthoclase crystals of large size. Quartz crystals also pronounced. Rutile—in acicular crystals—occurs in some of the quartz. Splendid examples of inter-growth of quartz and felspar crystals have been obtained from this reef: also of felspar twinning. Opened to about 12 feet in search of specimens.

Ike's Lode.—Head of Nuggety Gully, 4 miles from Copeton, Parish Clare, County Gough.

Inspector Carthew reported (P.B. 06, 1681) a large "quartzite dyke containing tin." Strike N.W. Width, 3 to 4 feet. Aid granted—patches of tin ore only—no permanent lode.

Jackson's Lode.—Near right bank of Topper's Gully, half mile from Middle Creek, Parish Herbert, County Gough.

Discovered by W. Jackson in 1872, but not tested until about 1892, when the vein was opened up for a few feet; and later by J. Lock.

Strike N.E. Dip vertical. Opened by trench 15 feet long and 12 feet deep in hard aplitic granite. Width of vein from 6 to 15 inches, consisting of crystallized quartz with much ironstone, carrying very narrow seams of cassiterite. Walls well defined. Output very limited.

Jones and Ribble's Lode.—150 yards N. of Cox's Lode; 1½ miles S.W. of Tingha.

Discovered by J. Cox about 1995, and worked by him for a few months; later by Hong Hay, and subsequently by Jones and Ribble until the beginning of 1909.

Strike E. and W. Vertical. Width, ½ to 2 inches. Veinstone quartz showing comby structure, parts passing into tinstone of a reddish colour. Opened by shallow trenching to a depth of 12 feet, with some driving, for a length of 300 feet along the strike. About 2 tons of coarse tinstone obtained.

Keihne's Lode.—400 yards east of Binghi Lode, west of Murray's Water. Parish Darby, County Hardinge.

Opened in 1906 by W. Keihne by shallow tunnel in hard granite. Strike E. and W. Dip steep to north. Width from ¼ to 14 inches thick. Veinstone-felspar and quartz, containing coarse cassiterite. Opened for a length of 40 feet, and depth of 12 feet. Barren in parts, and generally poor. About half a ton of tin ore raised.

Kelly's Lode (or "Pipe").—M.L. 30, Parish Herbert, County Gough, ½ mile south-west of Stannifer, near Stannifer–Tingha road.

Discovered by Kelly Brothers and P. Dwyer about 1905, and worked for about three years.

Lodestuff appears as chloritic granite, with prominent felspar and some scheelite in soft granite. No defined strike observable, but general trend is north-west; vertical.

At the north-west end an open cut 25 feet long and 30 feet deep revealed a floor dipping approximately south-east at 42°. A little prospecting, by trenching, was carried out along the supposed line of strike to the south-east, and a little driving from the bottom of the open cut.

Sinking was hard in the tin-bearing granite, which was about 9 feet wide at surface, tapering slightly in descent.

Extraction of the tin ore entailed roasting, crushing, and sieving. In all about 14 tons of fine to medium-grade tin ore were obtained. Scheelite occurred in association and afforded a marketable product.

Lane's Lode, between Firth's Hill and head of Herding Yard Gully, about 2¼ miles N.N.E. of Tingha, Parish Swinton, County Hardinge. Discovered by Lane in 1891.

Strike, north-east; vertical; width, 6 to 8 inches; veinstone quartz and felspar; a large white quartz vein occurs a few feet east, carrying but little tin.

Worked at intervals by Lane, Cameron and party, and Donoghue and party. Abandoned about 1904.

Estimated yield about 20 tons tin ore.

Leviathan Lode or Stockwork.—P.M.L. 1 and 62, Parish Auburn Vale, County Hardinge, 2¾ miles north-west of Gilgai, on Pine Ridge. C. S. Wilkinson in 1875, recorded "Tin ore in large crystals obtained from surface soil at Pride of the Ranges and Pine Ridge Tin Mines, Lower Cope's Creek. Small nests of the crystals have been found in the granite, but no defined lodes."*

As the granite range known as Pine Ridge trends south from west of Gilgai to Cope's Creek, it is evidently referred to in the above extract. The ridge is also noteworthy for the loose crystals of tinstone of high lustre.

* Mines and Minerals N. S. Wales, 1875, pp. 83, 84.

Gov. Printer.

Leviathan Battery, Pine Ridge.

(Auburn Vale Tin and Mineral Prospecting Company, Limited.)

The Leviathan lode was discovered by G. and T. Wright, who worked it for a short time. Subsequently secured by Messrs. Brown, and others in 1901, and worked as the "Leviathan Tin-mining Company," a 5-head stamp battery, Roby engine, Wilfley table and Frue vanner being installed about 42 chains south-west from the lode, at the dam site in Dick's Creek. Operations were, however, greatly hampered during the ensuing three years by water scarcity.

During the first six months, however, after completion of plant, 650 tons of lodestuff were extracted by the open-cut system from the north end of the lode, the concentrated yield from which was 15 tons of tin oxide; an average of 2·3 per cent.

Subsequently the property was disposed of to the present owners—The Auburn Vale Tin and Mineral Prospecting Company, Limited—who have continued prospecting operations for the past two and a half years, whilst supplying the battery with crushing stuff from open cuts and trenches.

The Writer is indebted to Mr. W. M. Goodwin, of Inverell, for the following statement of total output to end of 1908:—2,050 tons for a yield of 44 tons 11 cwt. 2 qr. 24 lb. of tin oxide, of a grade of 71 per cent. for "firsts," and 62 for slimes; an average yield of 2·17 per cent. of tin oxide, equal to 1·5 metallic tin.

The three open cuts vary from 15 to 25 feet in depth, and 10 to 15 feet in width, and extend in a north 20° east direction for 7 or 8 chains. Beyond this shallow trenches have revealed thin veins striking at various angles at the southern end for a further distance of 4 chains.

The stanniferous rocks consist of granulitic granite [7447–7448], greisen [7451], and porphyritic granite [7449]. The country is a granite consisting of quartz and orthoclase, and a little biotite [7614]. Associated minerals are topaz, in crystalline aggregates forming masses, thin plates of wolfram, cassiterite, and stainings of copper carbonates. In the bottoms of the open cuts arsenical pyrites, and arseniates are showing, with copper sulphides sparingly.

In the northern open cut a rich vein of tinstone occurred, but gradually gave out on its south-eastern course into a clayey seam.

Between the northern and middle open cuts a shaft was sunk a few feet to the east of the main body of lodestuff in normal granite. At 81 feet, a crosscut was driven west 50 feet in very hard rock, the stanniferous belt was cut in 15 feet from shaft, and proved about 12 feet wide. The crosscut being about 65 feet below the floor of the nearest open cut, an average sample was chipped from the full width of the lode which yielded the following results on assay:—

Tin	less than 0·5 per cent.
Copper	less than 0·5 per cent.
Zinc	a trace.
Arsenic	absent.
Bismuth	absent.
Nickel	absent.
Cobalt	absent.
Antimony	absent.
Tungstic acid	absent.
Gold	a trace.
Silver	7 dwts. 15 grs per ton.

An eastern crosscut was then driven to intersect the rich vein extending south-easterly from the northern open cut, but it had evidently thinned out entirely.

From the lower level veinstone 15 tons were submitted to battery and concentration tests :—5 tons, after preliminary roasting, yielded 2 cwt. of concentrates, of which half was estimated as tinstone. 10 tons, unroasted, yielded 570 lb. of concentrates of about the same grade.

L. A. Cotton, who investigated the results of metasomatism in the Leviathan lode, points out that the tin-bearing material gradually merges into normal granite constituting the country rock. Sections examined microscopically afforded abundant evidence of metasomatic replacement as defined by Lindgren.

The centre of a vein 11 inches thick proved very silicious ; the remainder showed abundance of a peculiar pale mica of a paragonite-sericite nature. This mica was found to replace the quartz, felspar, and biotite of the acid granite country.*

Lewis' Lode, 4 miles N.N.W. of Tingha, Parish Swinton, County Hardinge.

Discovered about 1899 by J. McGregor, and worked by him for a short time for a few cwts. of tinstone. Worked by H. Lewis from 1905, who obtained a fairly large quantity of ore. Strike east and west, vertical. In hard aplitic granite. Opened for about 120 feet in length ; and 12 feet in depth in places

Lion Lode, Portion 602, Parish Herbert, County Gough. In aplitic granite, with tugs filled with quartz crystals, which have again been invested with silica, filling the crystal cavities.

Lock's Big Lode, Lock's Hill, Parish Herbert, County Gough, $5\frac{1}{2}$ miles N.N.E. of Tingha.

Discovered by John Lock about 1894, and worked by him for about a year, during which he obtained 2 tons of fine black tinstone.

Strike north-east. Vertical. Worked by open cut 18 feet deep and 8 feet wide in moderately hard aplitic granite.

Near centre of worked portion the strike is deflected 10° north of its general trend ; at the bend the lode widened into the appearance of a "pipe." The pipe filling consisted of 15 inches of partly crystallized quartz, carrying blebs of tinstone. Tin ore occurred in the casing of the vein, as well as in the quartz.

Lock's Long Lode, near north-west corner of M.L. 92, Parish Herbert, County Gough, about $5\frac{1}{4}$ miles N.N.E. of Tingha.

Discovered by Mannix and Grant about 1894, and worked by them for a short time, then by Fletcher, Lock, and Wade at intervals. Idle since about 1908.

Strike north-east. Vertical. Veinstone quartz and felspar in aplitic granite. Average width about 1 foot. Carries tinstone in the quartz. Walls well defined. Opened by shafts, the deepest 30 feet. About 4 tons of tinstone have been won from the lode. Sinking soft to 20 feet. About a chain north-west a parallel large quartz vein occurs, but is almost barren.

Mannix's Lode, near Portion 268, Parish Herbert, County Gough ; at south-west end of Topper's Mountain.

Discovered by J. Mannix in 1903, who opened it to a depth of 20 feet. Thickness, 8 inches ; length of shoot, 9 feet. Two tons 5 cwt. of dressed tinstone extracted.

Re-opened subsequently by White, who sank to 40 feet, and obtained 2 tons of dressed tin ore.

* Proc. Linn. Soc. N. S. Wales, 1909, xxxiv, pp., 777-779.

McLeod and Wells' Lode.—3 miles S.E. of Tingha, Parish Cope's Creek, County Hardinge.

Discovered by McLeod and Wells, 1902. Worked intermittently for about two years. Vein 3 inches thick, containing coarse, crystallized tinstone. Opened by two shafts to 30 ft. level in hard granite. Three tons of tin ore won during operations.

Maher's Lode, Newstead.—A thin joint in aplite alongside the Newstead Lead—from a thread to an inch or two. Quartz studded with tin crystals forming a skin on joint faces.

Markham's Lode.—In N.W. corner M.L. 83, Parish Swinton, County Hardinge, 1½ miles N.E. of Tingha.

Discovered by G. Markham about 1889, and worked for a few months. during which several shafts were sunk to 30 feet.

Strike N.E. Dip fairly steep to north-west. Veinstone quartz and felspar in soft granite. Thickness 1 to 3 feet, of which from 2 inches to 1 foot was solid tinstone, which, however, cut out horizontally and vertically, causing the abandonment of the mine. About 7½ tons of coarse tinstone were obtained.

Mica Boulder Lode.—Newstead, near head of Karaula Lead, Parish Anderson, County Gough.

Strike N. 15° E. Tinstone discovered here in greisen, about 7½ cwt. being obtained to a depth of 15 feet.

Shaft sunk to 100 feet level about 30 feet away from outcrop and cross-cut to it—leaders only met at that level.

Mooney's Lode, 100 yards south of Brickwood Lode, near S.E. boundary of M.L. 388, Parish Swinton, County Hardinge, 2 miles N.E. of Tingha.

Strike N.E. vertical veinstone, mainly quartz, richest portions encased in decomposed felspar. Width of vein 3 inches, country granite. No defined walls. Opened by shaft to 20 feet, and driven on 100 feet at that level. Discovered about 1891 by Cooper who took out 12 tons of coarse tinstone. Reopened by Messrs. Mooney and Clarke with a view of further prospecting at lower levels.

Murray's Water Lode, discovered about beginning of 1908, 300 yards east of White's lode, near Murray's Water, Parish Darby, County Hardinge.

Strike E. and W. Vertical; width 2 feet. Veinstone eurite containing narrow quartz veins, fine-grained tinstone flank the quartz veins, and occasionally replace it for a few inches. The lode is formed from union of several such veins of felspathic material and quartz. Sinking moderately hard. A small quantity of ore won; lode comparatively poor.

McLeod and Smith's Lode.—On south fall of dividing range between Kelly's and Cope's Creeks, near Bull's Camp Gully, 5 miles south-easterly from Tingha, Parish Cope's Creek, County Hardinge.

Discovered by McLeod and Smith about 1894. Strike E. and W. Width from ¼ in. to 2 feet. Veinstone quartz and felspar, with fine tin in both. Opened by trench 30 feet deep, and driven east a few feet from bottom. Granite hard and dry. After obtaining about 10 tons of tinstone in about two years, lode was abandoned. Some desultory prospecting since with discouraging results.

The original prospectors opened a vein about 300 yards east, probably a continuation of the above.

New Chum Lode.—In head of Slurry Gully, near Tingha–Inverell road. Discovered by Phillips and Smith in 1908, under the alluvial, at a depth of 17 feet. Vein from 1 to 8 inches thick, proved for 6 feet in length.

New Cornwall Lode, Portion 80, Parish Anderson, County Gough ; about 1 mile south of Elsmore, on south side of Macintyre River. Outcrop not visible. Shaft sunk 200 feet in the early seventies, soon after tin mining began. It is reported that about 1 ton of tin stone was dollied from the vein. In the shaft spoil heap, the rotten granite still shows a little tin associated with molybdenite.

Basalt intervenes between the granite in which the lode occurs and the adjacent hill of sedimentary rock on the west, forming a narrow flat ; old shafts occur in the latter, but, according to local report, were not bottomed on account of water.

Between the lode on the margin of the granite and the flat, a shallow lead is being fossicked by Chinese.

Newstead Lode (also known as "White Elephant"), head of Puddling Machine Gully, west of Portion 73, Parish Anderson, County Gough. Shaft sunk in granite 200 feet ; then crosscut to lode channel. No ore visible at surface. Probably intended to test a crystallized quartz vein close by showing a little tin-stone in the quartz ; evidently the vein referred to by C. S. Wilkinson who, writing of this locality in 1875,* stated that :—

> "The rock formation at the Newstead Mine is of the same character as that of Elsmore. It consists of a porphyritic granite, traversed by tin-bearing quartz reefs and irregular beds and patches of micaceous rock. One of these small patches, which I particularly noticed, was about 18 inches in diameter, and thickly studded with crystals of tin ore.
>
> "One of the quartz reefs has been opened, and contains besides tin ore, iron and copper pyrites, green carbonate of copper, and wolfram. The reef is from 2 to 3 feet thick, and bears east-north-east. Very large crystals of quartz occur in it, some of which have crystals of tin enclosed in them. The above remarks apply also to the adjoining Karaula mine."*

Oliver's Lode, near Two-mile Creek, 3 miles north-east of Howell, Parish Mayo, County Hardinge.

Discovered by F. S. Oliver about 1903, and worked for about a year. A shaft was sunk, under aid from the Prospecting Vote, to a reported depth of 98 feet in hard aplitic granite.

Strike north-west, dip slight to east. Veinstone quartz. Width, 4 to 18 inches. The tin ore occurs in the quartz, and as a seam on either side of it. The upper portion of the lode is much broken, and consists of thin quartz veins in altered granite. Several tons of tinstone are reported to have been won from it.

Orchard's Lode, entering south-west corner of M.L. 401, Parish Cope's Creek, County Hardinge, ½ mile from Kempton Station.

Discovered by A. Orchard, senior, in 1891, and worked by him for six months, then sold to a Melbourne syndicate who had secured the adjacent Billy Barlow Lode. The syndicate sank 30 feet, and then abandoned the lode. Strike east-north-east in hard granite. Veinstone crystallized white quartz ; width, about 4 feet, but only a small portion carrying tinstone. Opened by several shafts, the deepest 60 feet ; 4 tons of coarse crystalline tinstone were obtained.

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* Mines and Minerals N. S. Wales, 1875, pp. 84, 85. † Mr. Thomas Gray, of Elsmore, who worked at Newstead in 1872, states that the first shaft was sunk on the quartz reef mentioned.

Partridge's Lode.—Near north boundary of Portion 165, Parish Swinton, County Hardinge, near Butchart Lode, 2 miles north of Tingha.

Discovered in 1886 by M. Partridge and worked by him for about two years and then abandoned. Strike east and west, vertical. Width averaged 18 inches. Veinstone quartz, and decomposed granite.

This lode was traced from the "Potato Patch," where rich shode stones were obtained in the soil. Where quartz formed the lode filling it was practically barren; but in the decomposed granite tinstone occurred in thin parallel seams, and was fairly rich. No defined walls occurred. Sinking was dry to 91 feet, when considerable water was encountered. The lode was opened by a trench 100 feet long and 16 feet deep, and a 90 feet shaft at the east end. This shaft in rotten granite required close timbering, the softness of the granite and heavy water are reported to have caused cessation of operations. At the 90 feet level the lode is stated to have consisted of crystallised quartz, with a thin coating of tinstone on each side.

Partridge is reported to have obtained 100 tons of tin ore from an area of ½ an acre, mostly from the "Potato Patch."

Patt's Lode, near White's Lead, 2½ miles southerly from Tingha, Parish Cope's Creek, County Hardinge.

Discovered in 1894 by S. Patt. Strike east and west in granite, veinstone mainly crystallised quartz for the first few feet, then partly replaced by decomposed felspar. Large quartz crystal aggregates occurred in a vugh. Width 6 inches. Opened by shafts to 20 and 40 feet. About 2 tons of tinstone obtained.

Pike and McKay's Pipe Lode, ¼ mile north-east of *Simoni's Lode*, in McCrohon's Paddock, Parish Cope's Creek, County Hardinge.

Discovered by Pike and McKay in 1894, and worked for six months under aid from Prospecting Vote. The pipe is of oval shape, up to 10 feet in diameter, consisting of hard felspar requiring explosives. Fine-grained tinstone occurred on north side for a thickness of 4 feet. Occasional vughs contained solid lumps of cassiterite with crystallised quartz. The pipe was rich for first 0 feet in descent, but gradually became impoverished. The general underlie was to the south, where the pipe approached the horizontal. The tin made richest where the dip neared the vertical. It was followed to 80 feet. About ½ tons of tinstone were obtained.

Pine Ridge and Pride of the Ranges Mines.—(*See* Leviathan.)

In 1875 C. S. Wilkinson described large crystals of ruby, red, amber, and other coloured tin oxide from the surface of these mines, but beyond small tests of crystals in the granite, no defined lodes were found.

Porter's Lode.—North-east corner of Portion 2, Parish Swinton, County Hardinge, 2¼ miles N.N.W. of Tingha.

Discovered by W. Porter, about 1889, and worked for a few months, then abandoned for four years, then further tested by M. Partridge and others.

Strike east and west, vertical. Width about 4 inches; veinstone in parts most solid tinstone, in others replaced by quartz. Occurs in quartzite for the most part, near junction with granite.

Opened by trench 30 feet long and 18 feet deep; and a shaft 50 feet deep with a little driving. At the 50-feet level the reef entered aplitic granite as solid vein of ironstone without tin. Walls well defined in the granite, but not in quartzite. Sinking dry and hard.

Abandoned about 1901. In all about 4 tons of coarse tinstone were obtained from the lode.

Adjoining the south boundary of the same portion another small lode ir aplitic granite was opened many years ago. Strike east and west; dip sligh to south; walls well defined.

Quinn's Lode.—At head of Cain's Lead, 1 mile west of Stannifer, Parisl Herbert, County Gough.

Discovered by Quinn Brothers, in 1895, and worked by them for abou eighteen months.

Strike, north and south, vertical. Veinstone, decomposed felspar in sof granite. Opened to a depth of 30 feet. No defined walls. A narrow vein—becoming lens-shaped at intervals. Proved for about 10 chains i length. Probable source of tin in Cain's Lead.

Racecourse Lode, near north-west corner of Portion 19, Parish Darby County Hardinge, $\frac{3}{4}$ mile south of Tingha.

Strike, N. 80° E. Vertical. Very narrow vein in granite. Opened b shallow trenching for 30 feet. Tin-ore, medium-grained.

Ravenswood's Lodes, Oliver's Gully, between Two-mile Creek and Quar Pot Gully; about 3 miles northerly from Howell, Parish Mayo, Count Hardinge.

No. 1 crystallized quartz vein in kaolinized felspar and quartz. Thickness abont 4 to 6 inches. Tinstone occurs as a thin seam of $\frac{1}{16}$th of an inch thic on the walls of the quartz; the latter is formed of interlocking crystals i the centre of the vein. Opened by trench; unimportant.

No. 2.—At head of Oliver's Gully. Opened by shaft to 96 feet. Quar vein, with a few specks of tin oxide in somewhat circular form. Unimportan

No. 3.—Near No. 2. Flat, banded vein, formed of alternate bands crystallised quartz and tinstone; thickness about 3 inches. 56 lbs. of clea tinstone reported to have been discovered in one block.

Reeve's Lode.—Head of Long Gully, Eastern branch of Sutherland's Wate Parish Cope's Creek, County Hardinge.

Opened by Reeves in 1879, and worked by him for about two years, durir which a shaft was sunk on the vein in hard granite to a reported depth 200 feet.

Strike, east and west; dip, vertical; veinstone, quartz. Tourmaline occu in the granite adjacent to the lode, and sometimes in the quartz. Width, to 18 inches. Opened by drives east and west from the bottom of the sha for 50 feet along the lode. 90 tons of coarse black tinstone reported to ha been obtained. Abandoned since 1895. Sinking dry, in hard granite.

Rex Lode.—Middle Creek. Quartz veins in granite.*

Richard's Lode.—In Shivery Gully, near south-east corner of M.L. 34 Parish Swinton, County Hardinge, $1\frac{1}{2}$ miles west-north-west of Tingha.

Opened by E. Richards in 1907, who obtained about 9 cwt. of crystallize tinstone. Strike, east and west; vertical. Width up to 3 feet in place Veinstone, quartz, with occasionally felspar, and a little tin. Two other sma veins occur a few feet away, west and north, each carrying a little tin. Ma Main lode opened by two shafts, 33 and 45 feet deep.

Rooney's Lode.—$\frac{1}{4}$ mile north of Moore Gully; 5 miles south-east Tingha, Parish Darby, County Hardinge.

Discovered by F. Rooney about 1889, and worked by him for a sho period; then sold to E. R. Davis, who sank 70 feet in hard aplitic grani

* C. S. Wilkinson, Mines and Minerals N. S. Wales, 1875, p. 82.

The vein was rich for the first few feet in depth, but rapidly became impoverished. Davis erected a small stamper battery at the junction of Moore Gully and Sutherland's Water, for the purpose of treating the veinstone from this and other lodes, but the venture was unprofitable.

Rooney's Lode.—Slurry Gully, near Tingha–Inverell-road, 1½ miles N.W. of Tingha, Parish Swinton, County Hardinge.

Discovered by Rooney about 1892. Strike E. and W. Veinstone hard white felspar and quartz, with coarse tinstone. Opened by shafts from 34 feet to 100 feet; sinking hard and wet. 13 tons of tinstone were obtained from the deepest, and 15 tons from the 34 and 60 feet shafts. Abandoned about 1894; but reopened at the east end for a period.

Sam Ah Cue's Lode.—M.L. 345, Parish Swinton, County Hardinge; 1¾ miles N.E. of Tingha.

Discovered by Ah Cue in 1908, under basalt soil. Strike N.E., dip N.W. Width from ¼ to 1 inch. Opened to 20 feet. About 5 cwt. of coarse black tinstone obtained.

Saunder's Lode.—¼ mile east of Sutherland's Water, Parish Darby, County Hardinge, 2 miles S.W. of Tingha.

Discovered by S. Saunders in 1904, and worked by him until close of 1908; afterwards prospected by Kiehne and party. Strike E. and W. in hard granite, vertical. Veinstone, mostly hard white felspar, with fine-grained tinstone. Opened to 30 feet, with narrow drive following vein striking at right angles. About 8 tons of tinstone reported to have been won.

Scotch Thistle Lode.—Near right bank of Sutherland's Water, Parish Darby, County Hardinge.

Discovered by T. Wells about 1905. Strike east and west in hard blue granite. Dip, slight to south. Thickness from ½ inch to 4 feet, carrying coarse tinstone. Country mostly soft adjoining vein. Hanging wall well-defined.

Cross-section.

1 inch coarse tinstone.
2 inch light coloured granite.
Hard blue granite, with porphyritic felspar.

Carbonates of copper are present in small amounts along the joint planes in several places near the tin vein. Opened to 35 feet and 30 feet by shafts, and connected by driving about 20 feet. Approximately 5 tons of tinstone taken out to end of 1909, being worked at that date by Freirthick and Sons. Sinking dry, but hard.

Selling's Lode.—M.L. 335, Parish Swinton, County Hardinge, about 1 miles west of Tingha. Worked about 1902 by J. Sellings, and subsequently by T. Jones.

Strike E. 5° N. Dip southerly about 1 in 6. Veinstone quartz and felspar, in soft granite. Opened by two shafts, 30 and 40 feet. Approximately about 6 tons of tinstone obtained.

About ½ chain west another lode was discovered by Cox, senior, and worked by Cox Bros., and 3 tons of tinstone obtained. Opened by two shafts, 50 and 80 feet; sinking dry and easy. On either side of lode, the veining of felspar and quartz up to 2 feet thick, carried a little fine tinstone in places.

About 8 chains west of Selling's lode, a similar lode of decomposed felspar in soft granite was discovered. Worked intermittently for several years yielding several tons of fine tinstone. Recently worked by Cox Bros., and to a lesser extent by E. Richards. The lode is stated to have been 2 feet wide in places, carrying a little fine tinstone.

Simoni's Lode (Bolitho).—12 chains S. 70° W. from north-west corner of S.L. 96. Two miles south of Tingha, Parish Darby, County Hardinge.

One of the earliest discovered lodes in the field, described by C. S. Wilkinson in 1872:—

> "Another reef has been struck in Simoni's mineral lease, near Sutherland's Water. It consists of an irregular dyke or vein of felspathic granite about 2 feet thick, traversing in a direction E. 15° N. porphyritic granite. Narrow veins of quartz run through the dyke, and both it and the quartz contain thin lodes and patches of pure tin ore beautifully crystallised. The stone is much stained with green and red oxides of iron."*

In 1875 the same authority recorded that:—

> "The tin ore at the Bolitho Mine (generally called Simoni's) runs in irregular veins through a felspathic dyke about 18 inches wide, and dipping nearly vertical. Occasionally these veins of ore unite, forming an almost solid mass of ore; and again thin out and are lost for a time. Several large blocks of the veinstone, one weighing nearly half a ton, were raised, the greater part of which consisted of tin ore."
>
> "About half a mile to the westward another lode of tin ore has been discovered on Thompson's land; it occurs in hard granite; is about 3 inches thick, with a thin parting of quartz running along the middle of it; and its bearing is the same as the other lodes in this district, about east-north-east."†

It is reported that Simoni sank 80 feet in the lode, and obtained 30 tons of tinstone; he then sold to Litchfield and others, who sank a shaft 60 feet from the first, to a depth of 183 feet on the lode through hard blue granite. At this spot it varied in width from ¼ to 6 inches, and consisted mainly of quartz with thin seams of tinstone; the latter gradually giving out in depth. Abandoned for some years. Held for a short time in 1908–9 by Paterson and others.

G. W. Card describes the two types of granite at this mine, as follows:—

[7492.] Granite.

> "A porphyritic variety.
>
> "Plagioclase equals or, perhaps, exceeds orthoclase in quantity. Some biotite and hornblende present, with apatite, sphene, and iron ores as accessories. The orthoclase is somewhat cloudy, and shows intergrowth of individuals. It contains some secondary mica. The plagioclase shows very distinct zoning, and mottling due to irregularities of composition."

[7491.] Granite.

> "Orthoclase and plagioclase (a fairly basic variety) are present in about equal quantities, the variety Adamellite. Much apatite and some iron ore as accessories. Felspar is partly replaced by white mica."

Smith's "Pipe" Lode.—About ¼ mile south of Tingha, New Valley road, Parish Cope's Creek. County Hardinge, 2½ miles south-east of Tingha.

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* Tin-bearing country, district of Inverell. Legislative Assembly Papers, 176—A, 1873, p. 2.
† Mines and Minerals N.S. Wales, 1875, p. 83.

Discovered by S. Smith, about 1894. Varied from oval to circular in form and from 3 to 5 feet in diameter. At surface was extremely rich, especially at the centre of the pipe. The matrix was felspar, and the tinstone fine-grained. Much of the pipe filling, however, was practically barren.

The general trend is stated to have been north-easterly; and the dip alternated between horizontal and vertical, changing every 10 or 12 feet. About 1898 Parker and party sank a vertical shaft to meet Smith's shaft following the pipe, at 42 feet from surface. The pipe in the former was followed from that level to 90 feet, the greatest depth reached. The underlay was fairly constant, but heavy water and inclined grade from bottom of shaft prevented further development. Tin ore is reported at the lowest level, where the pipe has a diameter of 4 ft. 6 in. The country being decomposed required close timbering. Unlike most of the Tingha "pipes," the filling was harder than the enclosing country. The Parker syndicate obtained 4 tons of medium-grained tinstone, the pipe material averaging 4 cwt. to the load.

Smith's Lode.—On south fall of range, between Kelly's and Cope's Creeks, near head of Bull's Camp Gully, 5 miles east-south-east of Tingha, Parish Cope's Creek, County Hardinge.

Apparently a continuation of Wilson's Reef.

Discovered about 1894. Strike east and west. Opened by trenching and driving for a short distance. Abandoned about 1896, after extraction of about 1½ tons of fairly coarse tinstone. Sinking, hard and dry.

Smith and Barnett's Lode.—Near south boundary of Portion 18, Parish Cope's Creek, County Hardinge, on right bank of Darby's Branch.

Discovered about 1904, 5 to 8 feet below surface of alluvium whilst prospecting for stream tin. Strike N. 50° E. Vertical. Width, from ¼ to 6 inches. Veinstone crystallized quartz, with coarse tinstone. Opened by three shallow shafts about 15 feet deep. About 1 ton of tinstone obtained. Abandoned in 1904.

Smith and Wilson's "Pipe" Lode.—Upper portion of Moore Gully, the west branch of Sutherland's Water, near Hay's old sheep station, Parish Darby, County Hardinge.

Discovered about 1896, but abandoned after sinking a few feet. Reopened in 1908 by Smith and Wilson to a depth of 16 feet, and again abandoned. The pipe material consists of decomposed felspar, in which abundant perfect crystals of quartz, about ½ inch long, occur. In the north-east part of the pipe a vein of quartz occurred, carrying a small quantity of fine tinstone. A "bunch" of quartz crystals and felspar in the centre of the pipe yielded 1¾ cwt. of fine-grained tinstone. It occurs in hard aplitic granite.

Stannifer-Bischoff Lode—Portion 300, Parish Herbert, County Gough, near Boney Gully.

Discovered by Mannix Bros. in 1880. Sold to D. Dougherty; and subsequently floated into the Stannifer-Bischoff Tin-mining Company. Described by C. S. Wilkinson in 1883 as :—

> "One of the most promising lodes in the district, the tin is disseminated in separate grains or crystals associated with fluorspar, through porphyritic granite."*

It is reported by Mr. Coade (at one time manager) that the lode formed a lens about 70 feet long, and yielded from 30 to 40 tons of tin ore to a depth of 55 feet. A five-head stamper battery was erected by the Bischoff Company in 1887 on Boney Gully, where water was conserved by damming.

* Ann. Report Dept. Mines for 1883, p. 152.

A shaft was sunk in the granite away from the lode to a depth of 180 feet; the lode intersected at that level was comparatively barren.

In 1884 Mr. Inspector Slee reports a considerable amount of work for little success.

In 1905 Stormer obtained about 1 ton of tin ore from a surface bunch in granite, but it is reported to have pinched out in a few feet.

Stiveley's Lode (also known as "Cowan's").—M.L. 423, Parish Cope's Creek, County Hardinge, 4 miles south-east of Tingha, near Kempton Station.

Strike N. 80° E. Thickness, 1 to 6 inches, in soft micaceous granite. Opened by shaft to 100 feet. Water heavy. Reported that about 20 tons of tinstone were obtained during operations some years ago.

Stormer's Lode, alongside Inverell-Armidale road.—M.L. 3, Parish Herbert, County Gough, about 4 miles east of Stannifer.

Discovered by T. Stormer in 1891, and worked for some months. Then abandoned for about four years. Reopened by J. Stormer, who discovered the richest shoot so far.

Strike N. 50° E. Opened by trenches and two shafts for about $3\frac{1}{2}$ chains. Veinstone quartz. Thickness about 6 inches. The deepest shaft is about 30 feet. The tinstone occurs as seams in the quartz. About 13 tons are reported to have been obtained to date.

Stormer's Rock Hole Lode.—About 40 chains north-west of M.L. 3, Parish Herbert, County Gough.

Discovered October, 1909, in a bare outcrop of granite. Two veins cross, one striking N. 50° W., the other N. 47° E. Tinstone shows at the junction for a width of 6 inches, and a pipe is probable. Quartz and fine-grained aplitic granite form the matrix (unopened).

Stormer's Tin "Blow."—$\frac{1}{4}$ mile south-east of Stannifer.

Discovered by J. Stormer about 1900, and worked for a few months. Aid was granted from the Prospecting Vote to sink a shaft, which was carried down 70 feet. The deposit was opened for a length of 50 feet by a width of 5 feet, tinstone occurring through the granite at short intervals throughout. Copper carbonates and copper pyrites appear sparingly at the lowest level. About 12 tons of tinstone are reported to have been obtained from the lode, and 4 tons of loose shed tin from the surface.

Surprise Lode.—$\frac{3}{4}$ mile west of Tingha Racecourse, Parish Darby, County Hardinge.

Discovered in 1907 by T. Sharpe; worked by D. Pasmore in 1908. Strike east and west. Vertical. Veinstone altered granite, with much felspar and some quartz. Width, from 6 inches to a foot, with disseminated tinstone. Granite hard; no water. Opened by two shafts to 20 and 25 feet. The tinstone is medium to coarse grained. About 1 ton of ore obtained.

Sutherland's Water.—A lode occurs about 300 feet above the Tingha Consolidated Tin Company's No. 6 dredge, near M.Ls. 24 and 25, Parish Darby, County Hardinge, on the bank of Sutherland's Water.

Strike east and west in hard blue granite, near junction of aplitic granite. Veinstone mainly felspar, with some quartz; tinstone coarse. Opened for about 100 feet in length.

Taylor's Lode.—M.L. 83, Parish Cope's Creek, County Hardinge.

Discovered by G. Taylor about 1905, whilst tunnelling under basalt at Red Hill. Strike north and south. Width, 6 inches. Veinstone mainly felspar, with a little quartz; in soft granite. Worked for about twelve months, during which about 16 tons of coarse black tinstone were obtained.

Tomlinson's Lode.—About $\frac{3}{4}$ mile north-west of Brennan's Lode, Parish Mayo, County Hardinge.

Discovered by S. Tomlinson about 1890. Opened about 60 feet in depth. Water heavy.

Tom Loy's Lode.—In bed of Irwin's Gully, below south boundary of M.L. 344, Parish Swinton, County Hardinge, 2 miles north-west of Tingha.

Discovered in 1908 by a Chinese named Lock, and worked by him and another for three months, during which they raised 4 tons of medium-grained, reddish-black tinstone. Contact lode at junction of granite and sedimentary rocks. Discovered under alluvial lead at a depth of 8 feet. It varies in width from 1 inch to 1 foot, and carries a vein of solid tinstone from a $\frac{1}{4}$ to 6 inches thick. Veinstone partly decomposed felspar, with veins of brittle white quartz. Alteration of the granite has taken place for a distance of 18 inches from the lode; this alteration produces fairly well-defined walls as the harder granite is approached at the 20 foot level. The lode strikes east and west, and is vertical. Opened by three shafts averaging 20 feet in depth. Apparently gives out to the west.

The lode is similar in both formations. Garnet, pyrites, hematite, limonite, and chalybite, occur as accessory minerals.

Too Tong and Ong Hay's Lode.—Left bank of Long Gully, above its junction with Bough Yard Gully, Parish Cope's Creek, County Hardinge.

Discovered about 1889. First worked by J. Whiteman and G. Hayden, who obtained a small quantity of tinstone, then abandoned it. Has been slightly worked at intervals since, when high tin values induced effort. Being worked in 1909. Strike east and west. Veinstone eurite, in hard felspar porphyry with phenocrysts of felspar up to an inch in length. Partakes somewhat of the form of a "pipe"; bunches 2 to 3 feet wide occasionally occurring along the lode. The thickness varies from $\frac{1}{4}$ inch to 3 feet. Sinking very hard and dry. The lode is being followed in an incline shaft some 20 feet in depth.

G. W. Card describes this rock as follows:—

[7556.]

"Under the microscope, abundant phenocrysts lie in a crypto-crystalline groundmass. The whole rock is very fresh. The phenocrysts consist of orthoclase, oligoclase, quartz, and much biotite. Corrosion is inconspicuous, the crystal edges being usually quite sharp. Shadow extinction is seen occasionally in the felspar."

The veinstone is first crushed on the usual "bucking" stone; then pulverized between steel rolls having a diameter of 4 inches; it is then wheeled to Long Gully (150 yards), where the tin is separated by the usual method of "banjoing." The yield at present is reported as about 2 cwt. per ton, but this is above the average.

Walmsley's Lode.—A few chains east of Boundary Lode; 3½ miles N.N.E. of Tingha, on boundaries of Parishes Swinton and Herbert, Counties Hardinge and Gough.

Discovered by R. W. Walmsley in the early days of the field, who sank a deep shaft in hard aplitic granite. Strike east and west. Vertical. Sinking dry. Walls well-defined. Only a small amount of tinstone obtained. Abandoned in a few months.

Wheal Australia Lodes.—M.L. 329, Parish Herbert, County Gough. Opened in 1887 by a company under the above name. Two parallel lodes occur about 36 feet apart, striking N. 55° E. These are intersected by a cross vein carrying oxide of iron. They occur in hard aplitic granite. The

thickness varies from a mere thread to several inches; but in the main lodes, where opened by two shafts, magnetic oxide of iron is closely associated with the tin oxide, preventing separation by ordinary washing appliances.

It is doubtful if the Company obtained any appreciable quantity of tin. But Messrs. Stormer Bros., in 1894, obtained 7 tons of clean tin ore about 1 chain from the westernmost shaft on the main lode.

At 5 and 9 chains south-easterly two other thin lodes were opened for a few feet by Messrs. Stormer, where small shoots of ore occurred; from these 25 cwt. and 30 cwt. of dressed tin were obtained.

Heading in this stanniferous belt a small channel—Wheal Australia Gully—trends northerly; which has been worked for stream tin for some little distance. It is thought that with a better water supply more tin might yet be obtained from it.

White's Lode.—On east bank of Murray's Water, Parish Darby, County Hardinge.

Discovered by C. White in 1905, and worked for a few months. Opened by two shafts 35 and 40 feet respectively, in soft granite. Strike east and west. Dip north at moderate angle. Width averages 12 inches. Veinstone, mostly hard white felspar with a little crystallized quartz. About 7 tons of coarse crystallized tinstone were obtained.

Yup See's Lode.—About 240 feet N.W. from N.E. corner of M.L. 364, Parish Swinton, County Hardinge, in bed of Irwin's Gully. About ½ mile above Tingha-Inverell road; about 2 miles N.W. of Tingha.

Discovered by Yup See in 1909, under 10 feet of alluvial whilst working stream tin. Strike east and west. Vertical. Water heavy owing to position. Width from ¼ to 3 inches of solid tinstone; in hard blue granite below 20 feet. About 6 cwt. of tinstone obtained. Working.

Outlying Occurrences.—Tingha–Inverell Division.

Happy Jack Lode, Reedy Creek, Mandoe Station, Parish Hallam, County Arrawatta; about 16 miles south-west of Bonshaw.

Discovered by J. O'Reilly and party in 1908. Strike, N. 75° W., in granite, close to junction of altered sedimentaries (Permo-Carboniferous Lower Marine Beds). Thickness at outcrop, about 2 feet, but thinned to a mere thread at 20 feet. Traceable for about 60 feet on surface. Tinstone in coarse crystals associated with tourmaline in greisen.

Across Reedy Creek, in a south-easterly direction, other tin-veins have been found by "loaming," varying from ¼ to ½ inch in thickness.

Reedy Creek here traverses the jointed sedimentary rocks. In small tributaries draining from the granite, superficial prospecting was carried on many years ago for stream tin; the quantity obtained was slight, judging by the extent of the workings.

In the vicinity, quartz veins of some width, carrying mispickel and a little copper pyrites, have been exposed for a few feet. A sample from a 4 feet reef yielded:—Gold, a trace; silver, 13 dwt. 17 grs.; copper, 1·12 per cent. No tin.

Another sample, on north-west of Happy Jack Lode, yielded:—Gold, a trace; silver, 1 oz. 17 dwt.; copper, 0·5 per cent. No tin.

The tin lode was opened under aid to about 30 feet, and then abandoned as the rich bunch of the surface gave out in depth.

Gragin (Caragin of the Rev. W. B. Clarke).—M.L. 1, &c., Parish Myalla, County Burnett, about 7 miles northerly from Delungra Railway Station.

In 1887 the Warden reported tin being discovered "on Gragin [Reedy.—J.E.C.] Creek, about 14 miles from Warialda; four leases were taken up. First prospects were encouraging, but on cutting into the hill the wash did not yield enough to warrant further outlay." *

Gragin tin deposits are reported to have been first opened by D. Wall and A. Francis in 1887, who sold to G. H. Gordon, of Gragin.

In July, 1901, John Cain and party applied for aid in Portion 100 (now partly covered by M.L. 1), the work already done being described as two shafts, 60 and 40 feet, and between 500 and 600 feet of driving. Aid was granted to drive 200 feet north from No. 3, or most northern, shaft, the rate being increased for the last 40 feet owing to influx of water. The Warden's bailiff, in measuring the final work, stated that the "further north they drove the less indication they got."

Inspector Carthew was shown two diamonds, when inspecting the site, which were reported to have been found in the wash. On the date of a further inspection he reported a small diamond being found. The party abandoned the site on completion of the grant.

Eventually possession was taken by Benjamin Bridge, who extracted some tin ore during the five years he held it, subsequently selling to the Gragin Alluvial Tin-mining Company, which began operations about April, 1910. On the 22nd July the machinery was started. The initial plant consists of an engine and pump for lifting the water to the sluice-boxes at the tunnel mouth, the intention being to make a practical test of the wash before attempting more elaborate installation.

The geology embraces in descending order an olivine-basalt sheet, overlying a Tertiary channel drift (the original Reedy Creek), consisting of sandy pipeclay, sand, and pebble drift, resting on a granite bedrock. Away from the old channel to the north and west between the granite and the basalt are intercalated the basal conglomerates and sandstones of the Clarence Series (Jurassic?), which, further west about Warialda, cap the highest ranges.

Where denudation exposes outcrops of the basal conglomerate, and where disintegration has liberated the boulders and pebbles, a false impression of recent gravel deposition has been engendered. Along the course of Reedy Creek the overlying formations have been removed, and the channel track cut deep into the underlying granite, forming a narrow defile just above the mine, and an admirable dam site.

From the position of an isolated patch of basalt overlying drift, it is evident that the early drainage channel followed approximately the course of the present stream between this point and the principal workings. The critical question is, whether the former took a more north-westerly course than the latter below the tunnels. Upon this depends the extent of the available drifts, for if the two channels were coincident in direction, then only a limited stretch of the older remains, the rest being denuded from above the course of the present stream.

The following sections of the channel filling were measured in different parts of the main tunnel :—

Sandy pipeclay roof.

ft.	in.	
1	6	grit with small pebbles.
1	0	pebbly drift and coarse grit.
0	7	fine grit.
1	1	pebbly drift.

Granite bedrock.

Gritty pipeclay roof.

ft.	in.	
1	9	coarse grit,
2	0	fine pebbles and coarse grit.
2	7	pebbly (quartz) wash.

Granite bedrock.

* Ann. Rept. Dept. Mines for 1887, p. 89.

The Gragin Company mined and put through the sluice-boxes 400 cubic yards of wash from the main deposit for a return of 17 cwt. of 74 per cent. tin ore, equal to 4·75 lb. per cubic yard. With the tin was a larger bulk of black sand and gem stones, which in the ordinary prospecting tests conveyed an erroneous impression of richness.

The Company thereupon abandoned operations and forfeited its leases. Before it had installed any machinery the Writer sampled the wash for a return so much below the Company's own sampling as to induce him to communicate the results to its local representative—with a warning to undertake further sampling before expenditure.

Dumboy and Pine Creeks.—Tributaries of Sheep Station Creek, Parish Delungra, County Murchison. About 3 to 5 miles from Delungra Railway Station ; on Myall Creek Pastoral Holding.

Tin ore has been known in this locality since about 1887, when eight leases for tin-mining were taken up, but no work was done. About 1893 several tons of stream tin were obtained from the drift in Dumboy Creek.

In 1899 Warden Lawson reported further discoveries, and fourteen applications for leases were received. Both lode and alluvial tin were being prospected a short distance west of the creek. Rich samples were obtained from the cap of a lode, and from the shallow alluvial.

In 1904 Inspector Carthew examined a lode 1 mile west of Dumboy Creek consisting of tinstone in quartz traversing granite. Strike north-east. Aid granted to sink from 25 feet to 100 feet. Later reports describe the lode as 18 inches wide at 50 feet, with vein of tinstone in centre. At 82 feet, 4 cwt. of tinstone were extracted. Prospects not being sufficiently encouraging, work ceased.

Another lode in the vicinity also received aid from 19 to 100 feet. Tin and native copper were reported occasionally visible in the stone.

Examined by the writer in December, 1908. A small area of granite is exposed in this locality amidst the surrounding basalt, which overspread the country.

Stream tin has been worked to a small extent in the creek bed, and in shallow surfacing on the west side. The latter is too poor to pay for cartage, and insufficient for installation of pumping plant.

A number of extremely thin veins of quartz and tinstone occur in the granite, usually not more than $\frac{1}{4}$ to $\frac{1}{2}$ inch thick. They are usually associated with fine tourmaline, which imparts a black appearance to the walls. Vughs occur lined with interlocked quartz crystals, also of dark colour.

Several shafts have been sunk following some of these veins ; two under aid. Campbell and party's, on the east side of Dumboy Creek, reached 40 feet in depth, and then was abandoned. The lodestuff consists of very schorlaceous rock, with a thin vein of tinstone.

On the west side, O'Shea received aid for sinking in similar country ; this shaft is the deepest on the field ; it followed a half-inch vein, which yielded a few cwt. of tinstone.

In portion 137, Oliver and party received aid to sink 100 feet in a dark crystallized quartz, carrying a little carbonate of bismuth.

Dumboy tin ore is of a resinous colour. A small hand-power stamper was installed for dollying the lodestuff.

Near the edge of the basalt in several localities between Dumboy and Gragin, cemented sand, known in the tin-fields as "Grey Billy," attests the presence of siliceous springs following the basalt extension ; the underlying sand drifts of old channels being converted into quartzites, and afterwards exposed by denudation of the basalt cover.

(*d*)—Wilson's Downfall Division.

The earliest geological report on this Division is by H. Y. L. Brown, formerly Geological Surveyor, N.S.W. (now Government Geologist, South Australia). In 1882 he visited the locality, and furnished the following notes*:—

"From Tenterfield to Wilson's Downfall the formation passed over is granite. The tin-bearing country, or rather that portion of it which has hitherto proved payable, commences near the Bookookoorara River, and extends northerly to Maryland Creek, being bounded on the west by the range forming the Queensland and New South Wales boundary. Wilson's Downfall, Herding Yard, and Ruby Creeks, with their numerous branches, appear to have been the chief centres of alluvial tin mining. They drain a section of the main range about 6 miles long, in the vicinity of the Sugarloaf, one of its summits, and flow into the Maryland and Wylie Creeks, which are branches of the Clarence River.

"The granite is generally of a coarse porphyritic character all over the district. Near Flint's selection, on Maryland Creek, it is replaced by schists, quartzites, and slates, with diorite dykes which continue on to near the village of Maryland, where there are also dykes of basaltic trap and granite traversing the quartzites and schists.

"Quartz veins are met in the vicinity of the main range and elsewhere. . . . . Tin ore attached to quartz is common in the alluvial drift here [near Sugarloaf.—J.E.C.], indicating the proximity of a lode. Dykes and veins containing tin ore have recently been discovered at the head of Herding Yard Creek. These deposits partake of the nature of lodes and dykes, the formations consisting of quartz, micaceous granite, micaceous quartz, &c., with crevices and cavities containing smoky quartz crystals; they occur in a belt of four or five, striking from north-east to south-west across the range, and are enclosed in granite, with an elvan porphyry dyke on the south-east, running parallel to them. . . . The ore is disseminated through the micaceous quartz and micaceous granite, and on the faces of the crystallized quartz veins. There is no doubt but that these belts of tin-bearing veinstone and dykes extend for long distances through the granite, and that the supplies of ore found on the alluvial flats of the creeks have been derived from them. . . . .

"Alluvial tin has been worked from the saddles of the main range at the heads of the creeks downwards for several miles. The sinking is shallow and of the ordinary kind, viz., through clay, sand, granite drift, and wash-dirt, the latter being sometimes in a cemented state. There is a considerable quantity of semi-rounded quartz drift in the wash, together with crystallized quartz, chiefly of the smoky variety. The wash is payable all over the creek flats in places, in others only narrow runs."

"Near Stormer's Gully, a branch of Ruby Creek, there is a cemented drift of older date than the alluvium, probably Pliocene, covering a flat rise, which has been worked for tin. In other parts of the district there are large areas of low sandy country which may be expected to be underlaid in places by similar tertiary deposits."

From the Warden's report for 1875,† it appears that mining commenced about the middle of 1872. The population at the end of 1875, amounting to 1,500, entirely supported by the tin-mining industry.

* Ann. Rept. Dept. Mines for 1882, p. 149. † *Ibid.*, 1875, pp. 56, 57.

"The principal supply of tin ore being won from the Two-mile, Wilson's Downfall, Cemetery, Herding Yard, and Ruby Creeks, and their watersheds from the main range forming the border between Queensland and New South Wales.

"On the opposite side of the range, the Sugarloaf, Quart Pot, and Lode Creeks constituted the principal tin yielders across the border.

"The principal mines, in 1875, were on the creeks mentioned; the stripping, or overburden, averaging about 8 feet, and seldom exceeding 12 feet; and the wash about 18 inches. The width of channels worked varied considerably; in Amos Bros.' claim, on Herding Yard Creek, it ranged over 300 feet, and yielded to the owners nearly 10 tons of tin ore weekly.

"The tin obtained from the heads of the streams high up against the range was coarse and little abraded, in many instances showing crystal facets. Lower down the channels the tin became fine with distance from its source in the range, until almost unrecoverable by ordinary sluicing appliances.

"Some attention was being directed to tin lodes; Dennis and Company secured land on both sides of the border, and erected a three-stamp battery on Ruby Creek. The first reef likely to be worked being in Queensland, only a few yards from the border."

Amosfield Claim.—Herding Yard Creek, 2½ miles north-west of Wilson's Downfall, M.Ls. 31 to 48 inclusive, Parish Ruby, County Buller.

Operations commenced by Amos Bros. in 1872, and continued until about 1887.

Average depth of ground about 12 feet, rich in both bed and banks of stream. Over 200 tons of tin obtained (now being worked by the Herding Yard Tin Dredging Company, no-liability).

Anderson's Gully.—Small left-bank tributary of Wylie Creek, heading in a small swamp adjoining Wilson's Downfall—Acacia Creek road, and flowing through Portion 18, Parish Wylie Creek, County Buller, into Wylie Creek, at Portion 309.

Mainly worked by the miner after whom it is named.

A small quantity of tin obtained from surfacing at head of gully.

Blackwall Gully.—Portion 401, M.C.Ps 35–37, Parish Ruby, County Buller, near Amosfield, 2 miles north-west of Wilson's Downfall. A small right-hand tributary of Herding Yard Creek. Tin mostly very coarse and but partially water-worn; ruby-coloured and black. Occurs usually in rich patches; average depth about 12 feet. Mining frequently hampered by water scarcity. Mainly worked by Chinese fossickers.

Bondi Sluicing Claim, Cemetery Creek. Adjoining Cemetery Creek claim up stream; 2 miles N.N.E. of Wilson's Downfall, Parish Wylie, County Buller.

Operations carried on contemporaneously with those of Cemetery Creek claim, the occurrence of tin identical in both, except for somewhat patchier gravel. Several tons of tin ore won—mainly by tributers.

Bookookoorara River.—The principal stream in the southern portion of the Wilson's Downfall tin district, receiving the waters of Two-mile Creek, Jenner's Creek, Six-mile Swamp Creek, Dan's Gully, and other channels.

The tin found in small quantities along this river represents denudation—chiefly in flood-time—of the stanniferous alluvials along the above-named stanniferous watercourses. It is mostly fine and water-worn; black and ruby-coloured, and associated with a notable proportion of black sand (ilmenite chiefly).

The river, for the greater portion of its course, flows through rocky gorges, with numerous small waterfalls, hence the tin drifts are confined to alluvial flats—usnally of small extent—formed at the debouchure of tributaries. Perhaps the most serious attempt to work this river recently was by Hughes in 1906, who erected a steam-pumping plant on its bank for the purpose of sluicing an alluvial flat on the west side between Six-mile Swamp Creek and Crisp's Gully, in Parish Bookookoorara, County Buller. A little fine water-worn tin ore, a little coarse gold, and a large amount of black sand were obtained. Operations were abandoned after six months' trial.

Patches of tin-bearing alluvium also occur some distance down stream in M.Ls. 7 and 50.

Small quantities of tin ore have also been won near the junction of Crisp's Gully, Portion 189; at the junction of Two-mile Creek in M.L. 5, Parish Corry; and some sluicing and driving have been done on the right bank, about half a mile above Two-mile Creek.

Buckingham Gully.—A small gully joining Wylie Creek in M.L. 27, Parish Ruby, County Buller, 1 mile west of Wilson's Downfall.

A small quantity of stream tin was won from this gully at its junction with Wylie Creek.

Caledonian Mine.—Two-mile Creek, Wilson's Downfall, near Tenterfield-road, Parish Corry, County Buller.

C. Pearce held a claim within the area; also held water-right in Two-mile Creek; carted shallow surfacing to creek. Rights purchased by present holders.

T. Byrnes discovered payable tin south of Pearce's claim, below false bottom previously worked. The intervening material being redistributed and compacted granite detritus, simulating bedrock. At a depth of 17 feet a patch of wash about 16 feet in greatest width yielded 3 or 4 lb. to the dish; about 13 cwt. of tin ore being blocked out by prospector. A little tin occurs through the whole of the surfacing, with some rich patches. Ground sluicing is carried on as water is available.

Cemetery Creek.—A left-hand tributary of Wylie Creek, heading near Wilson's Downfall-Acacia Creek road, in Portions 196 and 197, Parish Ruby County Buller, and flowing in a north-westerly direction for about 3 miles through the south portion of Parish Wylie.

This creek was originally fairly rich in tin contents (*see* Great Dividing Range, London, Bondi, and Cemetery claims). Black sand is prominent in the tin wash; gemstones have not been recorded. A little water-worn gold occurs with the tin in places, but is economically insignificant.

Cemetery Creek Claim.—Two miles N.N.E. of Wilson's Downfall, Parish Wylie, County Buller, near junction of Cemetery and Wylie Creeks. Originally worked as a sluicing claim by Messrs. Amos from January, 1874, to April, 1878; under management of W. Knight, after being unprofitably exploited by others in 1872–3.

Overburden averaged 10 feet in thickness of granite sand and clay. The wash ranged from 6 inches to 2 feet, and consisted of coarse, semi-angular quartz and granite drift, with occasional granite boulders. Channel up to 150 feet in width; worked up stream for about 300 feet. Three hundred tons of water-worn medium grade black and ruby tin ore reported to have been obtained, 25 tons being won by tributers.

A nugget (unabraded) of poor quality gold, weighing 2 dwt. 2 grs., was found by W. Knight in the streaming-box.

Cook's Gully.—A small gully near south boundary of C.P.L. 3,541, and entering Wylie Creek at north end of M.L. 322, Parish Wylie, County Buller, 4 miles north-east of Wilson's Downfall, near Liston-Rivertree road.

Overburden, reddish sand and clay; deepest, 20 feet near south boundary of the C.P.L. Worked mainly in the year 1890 by a Chinaman named Cook, after whom it is called. Cook is reported to have obtained 60 tons of fine angular ruby and black tin ore near the road mentioned, where a thickness of 8 feet of wash-dirt yielded $\frac{1}{4}$ lb. per dish.

This gully, however, proved very patchy in its tin contents. A little surfacing is now being carried on on the right bank. The bedrock consists of hard sphene—hornblende—porphyry, with occasional "bars" of aplite.

Crisp's Gully.—Between M.L. 23 and portion 189, Parish Corry, County Buller, about $2\frac{1}{2}$ miles north-east of Wilson's Downfall. A short left-bank tributary of Bookookoorara River. Worked mainly by J. Crisp between 1906 and 1908, who obtained 1 ton of medium to coarse angular ruby tin. Previously worked by J. Lamont, who also won a small amount.

Average depth of alluvial, 5 feet, consisting of granite sand, and clay, resting upon a few inches of partly water-worn quartz wash. Most of the tin was obtained from the banks, now practically exhausted. A small quantity of fine water-worn gold occurred with the tin ore.

Dan's Gully.—A small left-hand tributary of the Bookookoorara River, heading in W.R. 449, Parish Corry, County Buller, 3 miles south-east of Wilson's Downfall.

Worked intermittently for a number of years whenever water was available. Quantity of tin obtained insignificant.

Dickson's Gully.—Heading in the main range on the border of New South Wales and Queensland, and joining Ruby Creek in Parish Ruby, County Buller. M.Ls. 5, 8, 23, 25, &c.; about 7 miles north-west of Wilson's Downfall.

Discovered in 1872, and worked intermittently to the present time. Originally held and worked as a number of small prospector's claims. Average depth of overburden, 6 to 7 feet in the stream; deeper in the banks; width up to 3 chains. The wash was moderately rich, and consisted of partly abraded quartz and granite fragments, resting on an uneven bouldery granite bedrock. The wash was practically free from black sand. The tin is mostly very fine grained, water-worn, and mixed ruby and black in colour. Fossickers are hampered by water scarcity. The lower portion of the gully was worked for a considerable time by a miner named Dickson—after whom the locality is called.

Above the Stanthorpe-road the wash lies deeper; here a considerable amount of work was done by Chinese. The overburden consists of white granite soil with numerous large angular fragments of quartz showing occasional specks of tin and wolfram. Chalcedonic quartz and quartz crystals occur in the wash.

Between M.L. 8 and the junction with Ruby Creek in M.L. 25 very little alluvial occurs, but frequent patches of surfacing have been worked.

In M.L. 25 in this gully the Stormer's Ridge Tin-dredging Company constructed a large dam, from whence water was pumped into a race leading to their workings in New Zealand Gully, and on Stormer's Ridge.

Forbes Gully.—A tributary of Wilson's Downfall Creek, $\frac{3}{4}$ mile south-west of Wilson's Downfall. Mostly within M.L. 36, Parishes Corry and Wylie, County Buller. Heads in Macpherson Range, a few chains north of Stanthorpe-road.

Discovered by David Laird in 1872, and worked intermittently up to the present. At its head in a swamp a few trial holes, 14 feet deep, were reported unbottomed on account of water; the average overburden of the worked area is about 8 feet, varying from 1 to 25 feet, consisting of black soil, granite sand, and clay; resting on gravelly wash composed of coarse angular pieces of eurite, quartz, quartz crystals, chalcedony, and some felspar. The bedrock being hard eurite in the main (present) creek bed. The wash occurs rather in narrow gutters than one main channel. The richest portion of the gully lay between Silver Tin Creek and Wilson's Downfall Creek. The right branch of Forbes Gully is known as "Hungry Gully," which has been worked for a few feet in width along its bed for some distance. It heads in a swamp, and near the junction with Forbes Gully the alluvial is reported to average 20 feet near Palmer's Dam. Forbes Gully is shallow on the left bank, becoming deeper towards the main channel. A little fine tin occurs through the overburden.

A dredging lease has recently been taken up, embracing most of the alluvial (M.L. 36).

Graveyard Gully.—A small left-hand tributary of Cemetery Creek, near north-east corner of Portion 195, Parish Ruby, County Buller, $1\frac{3}{4}$ miles N.N.W. of Wilson's Downfall.

This gully was worked for a few chains from its junction with Cemetery Creek in the early days of the field, and is reported to have yielded a fair quantity of tin. Surface and shallow alluvial deposits occurred on a soft granite bottom. Much black sand present.

Great Dividing Range Claim.—On Cemetery Creek, adjoining London Claim up stream; on southern portion of M.L. 324, Parish Wylie, County Buller; $1\frac{3}{4}$ miles N.N.W. of Wilson's Downfall.

Operations carried on contemporaneously with those on the London, Bondi, and Cemetery Creek claims downstream.

As in the case of the London claim, the tin deposits proved heaviest in the main creek channel and on the right bank. Depth of overburden averaged 10 to 20 feet.

Several tons of partly water-worn tin were obtained, amongst which coarse angular resin and ruby tin oxide was prominent.

Half-mile Creek, Maryland.—A south bank tributary of the Maryland River, joining at the village of Maryland, County Buller.

Discovered early in 1873, and worked continuously by small syndicates and fossickers up to the present.

Tin mining is mostly confined to the central and upper reaches of the stream, where it traverses coarse granite; very little tin being found lower down where it crosses granulite and diorite.

Where worked, the bedrock is decomposed granite with wide bars of hard granite. The richest deposit of tin was found on the left bank within Reserve 33,395, where the wash had a thickness of 5 feet.

The alluvial varies from 1 to 20 feet, the latter depth occurring near the north-west corner of Portion 21.

About 30 tons of tin ore were obtained from a small area of this deep ground by Chinese in 1883.

Up-stream from this point the average depth is about 9 feet. The wash mostly coarse and water-worn, and frequently cemented, averaging 9 inches thickness. The tin is rather fine-grained, and consists of equal quantities ruby and black tin.

Topazes are numerous—some in crystals.

Operations have usually been hampered by shortness of water in the stream for washing purposes.

Darkey's Gully, a right-hand branch, has also been worked, but to a lesser extent. The tin in Half-mile Creek appears to have been partly derived from denundation of Pleistocene gravels, and partly from breaking down or weathering of a number of small tin-bearing quartz veins traversing the granite of the stream bed; these strike N. 70° E.

From this creek and tributary it is estimated that about 150 tons of tin ore have been obtained.

Herding Yard or Seven-mile Creek.—A tributary on right bank of Maryland River, rising near east boundary of Portion 282, Parish Ruby, County Buller, on north fall of Macpherson Range, 2½ miles north-west of Wilson's Downfall, and flowing in a general northerly direction.

At the head of the creek there is a depth of 10 to 20 feet of alluvium consisting of granite sand and bluish-white clay, resting on about 3 feet of coarse, angular, stony wash, with coarse, angular ruby and black tin, and some partly water-worn wolfram. Most of the tin oxide is crystallized and unabraded, having resulted from weathering of reefs in the immediate vicinity. The average yield equalled about ¼ lb. to the dish. Width of channel, 12 to 14 feet. Sinking practically dry. The tin gravels occur in narrow parallel gutters, with very uneven bottoms.

Where the tin yield depreciated, black sand increased. Reef quartz with crystalline cassiterite and wolfram was frequent in the wash, and identical in character with reefs *in situ* on the north side of the main range, in which the creek heads.

A small tributary on the west side, near the head, is known as Sloper's or Wilcox's Gully, from which a fair quantity of tin has been won, especially at the junction.

Hannon's, or Branch Gully, junctions about half-mile lower down on the same bank. From it also a small amount of tin was won from patchy ground.

An early reference* states that the

> "Most productive mine on the New South Wales side [of the border.—J.E.C.] is on Herding Yard Creek, Amos Bros. Yield for 1877, 482 tons. Width of wash very wide; stripping averaged 6 to 8 feet; wash about 2 feet thick."

Dredging is now in progress in Herding Yard Creek, near the Stanthorpe road, and was also carried on for a short period some distance lower down, in M.L. 327, parish Ruby. (*See* Herding Yard Dredge, Border Sluicing Company, and Wheal Edith Claim.)

Lakeland's Gully.—A small left-hand tributary of Wylie Creek, heading a short distance below the Wilson's Downfall-Acacia Creek road, joining Wylie Creek in M.L. 309, Parish Wylie, County Buller, 1½ miles N.N.E. of Wilson's Downfall.

A small quantity of black and ruby tin ore was won from this gully in M.Ls. 26 and 310. This gully, as well as its left-hand branch, Fern Gully, is swampy land. A fair amount of mining has been carried on in the deep ground, at its junction with Wylie Creek, some rich patches being met with.

Lincolnshire Gully (also known as Lancashire).—A left-hand tributary of Ruby Creek, heading in the Macpherson Range, and falling north into Ruby Creek in M.L. 14, at the Wilson's Downfall-Stanthorpe road, 5 miles W.N.W. of Wilson's Downfall, Parish Ruby, County Buller.

* Ann. Rept. Dept. Mines for 1877, p. 111.

At its junction with Ruby Creek a large dam was constructed by the Micalong Mining Company, to supply their Ruby Creek dredge. For about 20 chains above the dam, a small amount of work has been done in the creek bed and on the left bank. Above this, the gully bed is traversed by a hard aplite "bar" of considerable width, producing gorge conditions. Above this bar the gully again opens out into a generally level swampy tract, which has been worked nearly to the gully head, especially in the upper right-hand branch, where the alluvial attains a depth of 25 feet in places.

The tin obtained was angular, and in about equal proportions of ruby and black coloured; black sand absent. The tin-wash occurred in narrow runs.

Numerous thin quartz veins traverse the aplitic granite bottom, striking mostly about north and south. Frequent narrow irregular veins of greisen—striking approximately east and west—traverse the aplite of the upper half of the gully; fairly rich coarse tin is usually found on either side of these veins, and a little in the greisen itself. These veins frequently give out in depth a foot or so from surface; and have in no instance proved sufficiently stanniferous to work as lodes.

London Claim.—Cemetery Creek, Portions 115–117, Parish Wylie, County Buller, 2 miles north of Wilson's Downfall.

Operated between 1874 and 1878. Overburden varied in depth from 10 feet in bed of stream to 20 feet on banks. Several tons of partly water-worn ruby and black tin obtained, mostly from bed of stream and the right bank.

Maryland River (Generally regarded as the head water of the Clarence River).—Rises in the Macpherson Range, near Maryland Station.

Isolated patches of alluvial have been worked along this stream, but small quantities only of fine water-worn tin appear to have been obtained, a considerable proportion of its course being through rocky gorges. A little tin was being won from it in 1910 near the junction of Ruby Creek, the wash here consisting largely of granulite and diorite from the belt of altered igneous rocks traversed near Maryland Station. Small quantities of fine tin have also been obtained from near the junction of Wylie Creek.

Maryland Ruby Tin Mine.—Extending from M.L. 3 to M.L. 326 along Ruby Creek, in Parish Ruby, County Buller, 4½ miles north-west of Wilson's Downfall.

Operated between 1872 and 1878. Now being worked by Chinese. Average depth of overburden, 21 feet. A considerable quantity of tin ore obtained.

Mossman's Gully (or Telegraph Swamp).—A right-hand tributary of Ruby Creek, joining the latter in M.L. 6, Parish Ruby, County Buller, 6¾ miles north-west of Wilson's Downfall.

A small amount of tin was won from this gully at its junction with Ruby Creek.

Mother Fred's Swamp.—A right-hand tributary near the head of Maryland River, 1 mile north-west of Maryland, County Buller.

Numerous large water-worn ruby and black tin crystals were found along this stream near its junction with the river. Search revealed a small tin-bearing quartz vein at the junction of coarse granite and slate in the bed of the stream, about half a mile above the junction, but nothing payable.

A small amount of alluvial occurs along this swamp about the centre of portion 56, but not of importance. The water-worn gravel probably resulted from the redistribution of Pleistocene gravels occurring from the head of the swamp to the Queensland border.

Nelson's Swamp.—In a gully heading in M.L. 2, Parish Corry, County Buller, 2 miles south-east of Wilson's Downfall. It junctions with Jenner's Creek a few chains before the latter joins the Bookookoorara River.

Worked for some distance up from Jenner's Creek, in Portion 21. The tin occurred in a narrow run overlain by about 10 feet of black soil and granite sand; the total output, however, has been inconsiderable.

New Zealand Gully.—A branch on the left bank of Dickson's Gully, heading on the Queensland border, near the Stanthorpe-road, in Portion 22, and joining Dickson's Gully in M.L. 8, Parish Ruby, County Buller, 7 miles north-west of Wilson's Downfall, traversing M.Ls. 13, 15-19, 22, &c.

A considerable quantity of tin was obtained from this wide gully, especially on the west side adjoining Stormer's Ridge, the deposits consisted mainly of older alluvial.

For some distance below M.L. 22 the wash is overlain by yellow and white pipeclay, a pit in the above portion furnishing material for lining the bottoms of Silver Spur silver-lead furnaces.

The overburden increased to 30 feet in places, but became shallower down-stream. The wash was water-worn, and the tin ore fine and free from black sand.

The Stormer's Ridge Dredging Company sluiced this gully up-stream from M.L. 8 for a considerable distance; operations, however, have always been hampered by insufficient water supply. (*See also* Stormer's Ridge Dredging Co.)

Northern Boundary Claim.—Adjoining Amosfield Claim on Herding Yard Creek, up-stream. Portions 97, 99, 171-174, &c., Parish Ruby, County Buller.

Commenced about 1873, and worked until about 1875, when it was taken over by Messrs. Seeman and Flannery. The alluvial was very wide, but patchy in its tin contents. Average depth, 15 feet. The tin ore was very coarse, angular, and ruby and black coloured. A little wolfram was associated with it.

About 120 tons of tin ore were obtained.

Postle's Claim.—M.L. 12, Ruby Creek, Parish Ruby, County Buller, 6 miles north-west of Wilson's Downfall.

Worked from 1872 to 1874, and celebrated for its richness. The tin-bearing material representing natural sluicing in a narrow channel cut by the stream in its hard aplite bed. The whole of the deposit—6 feet thick—was wheeled from the creek to a shed, where it was streamed by water pumped by steam-power from the creek. Several hundred tons of ruby tin are reported to have been won from this claim.

Quarry Hill.—A low ridge close to the Queensland border, near the south east corner of Portion 64, Parish of Maryland, County Buller.

The granulite at this spot is highly contorted, with thin quartz veins between the bedding planes. Quarrying for railway ballast discovered a tin lode, and a considerable amount of ore was extracted with satisfactory results, according to report, but no work has been done for many years.

Ruby Creek.—A left-bank tributary of Maryland River, rising in the Macpherson Range, and flowing through the centre of the parish of Ruby, county Buller, north-westerly of Wilson's Downfall.

In its upper portion it traverses acid granite of aplitic type; below the Maryland-road it traverses sphene-hornblende-granite, conspicuously porphyritic by flesh-coloured felspars.

The tin obtained has been chiefly won from M.Ls. 3, 4, 6, 12, and 326. A narrow belt of alluvial has also been worked near its junction with the river in S.L. 08–12.

It is probable that a considerable amount of tin would be obtainable from the shallow surface deposits between Lincolnshire and Dickson's Gullies, if water could be elevated sufficiently to allow of gravitation sluicing. The average depth is about 10 feet, varying from a few inches to 16 feet, and consists of granite sand and bluish-white clay; the bottom wash is coarse and angular, and rests on soft aplitic granite bedrock, traversed by harder bars of aplite.

A considerable area has been worked as "surfacing" in M.Ls. 21, 22, adjoining the Queensland border at Lode Hill. Water being pumped from a large dam constructed for the purpose by a party of Chinese.

The tin in this channel has been derived from numerous small veins along the range within its watershed. Wolfram occurs associated with the tin in the quartz veins, and is present in small proportion in the wash. Specimens of "reef" tin and wolfram are common in the wash.

An extensive alluvial flat has been worked between M.Ls. 22 and 3: in M.L. 4 the creek bed is mostly rocky, with occasional patches of alluvial.

Most of the tinstone from this creek is ruby coloured (hence the name), with some black and resin tin.

(For further particulars, *see* Micalong, Dickson's Creek, T.M.D., Postles', Maryland Ruby, Silver Tin, and other mines and claims.)

A considerable quantity of tin was obtained from the Pioneer claim at south end of M.L. 6; also from the Champion claim at north end of same lease.

A little monazite occurred in M.L. 326 (Parish Ruby).

In 1908, several areas along Ruby Creek were taken up by G. W. Rhodda, a suction dredge purchased, and two dams constructed.

St. Leonards Claim Herding Yard Creek, Amosfield, adjoining Amosfield claim down-stream, Parish Ruby, County Buller.

Operations commenced in 1873, and continued until about 1877. Banks and bed of stream worked, the latter being the richest, the former patchy as regards tin values. Very little tin obtained below, about 8 chains north of M.C.Ps. 47 and 48. Over 40 tons tin ore obtained.

Silver Tin Creek.—A tributary on right bank of Wilson's Downfall Creek; 1 mile south of Wilson's Downfall, Parishes Corry and Ruby, County Buller. Heading in an eastern spur from Macpherson Range.

Discovered in 1872, and worked intermittently since by fossickers. Average depth of overburden, 6 to 15 feet; consisting of black soil, granite soil, and white clay, with large water-worn eurite boulders. The wash varies from 3 inches to 1 foot in thickness, and consists of somewhat coarse angular fragments of eurite, reef quartz, and chalcedony, yielding an average one lb. of mostly coarse, partially abraded, red and black tinstone per yard. Much of the tin from this creek had a silver sheen—hence the name. The richest portion worked was near the junction of Forbes Gully. Like most of the leads in this district, the tin contents were very patchy.

The channel averages about 1 chain in width, widening in places to 3 chains. The bedrock is eurite, and very uneven. A little fine tin is distributed through the overburden. Towards the head of the creek Paddy's Swamp occurs on the right bank; the depth of overburden here is reported as 25 feet.

A dredging lease, M.L. 33, embracing the major portion of the creek, was taken up in 1910. Water is usually abundant, and could be easily conserved.

Silver-Tin Mining Company.—This Company carried on tin-mining operations from 1872–1880, from the head of Ruby Creek on the Queensland border, down stream to M.L. 3, Parish Ruby, County Buller, 4 miles north-west of Wilson's Downfall. During its existence a large quantity of tin was obtained, especially between M.Ls. 3 and 22. The average depth was 22 feet. The material was paddocked, and the washdirt sluiced by water from a large dam at the north end of M.L. 22.

This area has since been continuously fossicked by Chinese.

Six-mile Swamp Creek.—A left-bank tributary of the Bookookoorara River, heading near the Tenterfield-road, and falling north-easterly, through sections 43, 44, 42, 41, 51, &c., to the river. Parish Corry, County Buller, 1 mile east of Wilson's Downfall. Heads in swamps, and flows through swamps for the whole of its course, excepting at the immediate outlet.

Towards the lower end the overburden thickens to 25 feet, consisting of black soil, granite sand, and loose drift. Sinking, wet.

Numerous races were cut in the early days of the field, but little mining was done, the prospects not being encouraging. A little fine tin is reported through the overburden, but the ground is patchy. Water for sluicing purposes is abundant.

Stormer's Ridge.—A low ridge forming in part, the boundary of New South Wales and Queensland; 7 miles north-west of Wilson's Downfall, close to Stanthorpe-road, and joining the west side of New Zealand Gully. Like the west side of New Zealand Gully, the alluvial deposits of Stormer's Ridge are older than the recent creek channel fillings.

Overburden 20 to 40 feet, consisting of yellowish-red and white pipeclay; wash, medium to coarse and well water-worn. No black sand. Sinking, dry on crown of ridge, wet on fall to New Zealand Gully. Average yield, 30 lb. per yard; with some very rich patches.

A considerable amount of tin ore was obtained from the "Wheal Whar Mine" in the early days of mining at the lower end of New Zealand Gully.

The tin was confined to thin seams in the wash and on the granite bedrock, aggregating from 6 inches to 2 feet in thickness.

This older formation has been worked continuously across the border into Queensland. A little wolfram is associated with the tin on the southern portion of the ridge.

Two-mile Creek.—A left-bank tributary of the Bookookoorara River, heading in the Macpherson Range, and flowing easterly to the river, 2 miles south-south-east of Wilson's Downfall, Parish Corry, County Buller.

Discovered to be tin-bearing about 1873, and worked intermittently since, mostly by Europeans and some Chinese.

Average depth about 6 feet, varying from 1 to 14 feet. Overburden black soil, bluish clay, and granite sand, resting upon 3 inches to 3 feet of coarse, angular stony wash, averaging 1 ft. 6 in. The wash occurs in narrow parallel runs, and is very patchy in tin contents. Bedrock, bouldery and uneven for the most part. The creek was fairly rich near the north-west Portion of M.L. 2, Parish Corry. The tinstone is mostly of the ruby variety, and fairly water-worn. A few sapphires, garnets, topazes, &c. are found associated, at the lower end principally. Black sand is present to a moderate extent. No wolfram detected.

A tail-race was cut through hard granite, traversing occasional aplite bars, at the lower end of the creek for some distance.

Average yield about ¼ lb. per yard. Several hundreds of tons of tin have been won from the Two-mile up to date. Small quantities are now being won by sluicing left blocks of previous operations near the junction of the Bookookoorara River; also by the Two-mile Dredging Company (Limited), (which see). Messrs. Hughes and Wilson are sluicing a surface deposit near by on the south in M.L. 2.

Two-mile Swamp, or Molly's Gully.—A right-hand tributary of the Maryland River, rising in the Macpherson Range and flowing north-east, about 9 miles north-west of Wilson's Downfall, Parish Ruby, County Buller. Discovered in 1873.

Most of the tin-bearing alluvial in this stream occurs between the Queensland Border and the south-east corner of Portion 67. The average depth is about 10 feet. The bedrock is soft granite, with occasional aplite bars. Wash-dirt patchy, but occasionally rich. Operations hampered by water scarcity.

Ward's Gully (also known as Mossman's Gully).—A left-bank tributary of Ruby Creek, three-quarters of a mile up stream from Dixon's Gully, Parish Ruby, County Buller; 5¾ miles north-west of Wilson's Downfall.

Most of the alluvial and surface deposits at Ward's Gully occur in isolated patches on the left bank. From the Stanthorpe-road to its junction with Ruby Creek they occur in the creek bed and banks. Above the road the greater part of the bed is bare granite.

Operations are usually hampered by insufficiency of water for sluicing purposes.

Tin occurs throughout the shallow overburden, mostly angular ruby and black tin, medium to fine-grained.

Wheal Ethel Claim.—Herding Yard Creek, near corner of Portions 51, 53, Parish Ruby, County Buller, 5 miles north-west of Wilson's Downfall.

Operations began about 1873, and continued for a few years. Average depth of overburden 10 feet, mostly drift sand. Richest deposits occurred in the creek beds, with narrow runs of fairly good ground being worked up to the surface on left bank.

The wash was coarse and angular, with water-worn medium-grade ruby tin. A little fine tin distributed through overburden. A few tons of tin were won by the original holders, since then it has been mainly fossicked by Chinese.

Wilson's Downfall Creek (known as Wylie Creek below Village of Wilson's Downfall),—heads in low spur from Macpherson Range, and traverses M.Ls. 30, 29, 28, 27, and 308, Parish Ruby, County Buller.

Overburden varies from a few inches to 22 feet in thickness, averaging about 10 feet. Wash from 6 inches to 2 feet, bed-rock bouldery and uneven, consisting of decomposed porphyritic granite and aplite.

The greater part of the tin ore won from Wilson's Downfall Creek was coarse and angular, and accompanied by occasional small sapphires, topazes, zircons, and garnets, and a small amount of black sand.

The tin occurrences along the stream are very "patchy." Numerous short gutters have been followed for short distances.

The tributaries nearly all rise in level swampy ground. Funnel's Flat occurs near the head in M.Ls. 28, 29, the overburden being 6 to 8 feet, and carrying a little tin.

The wash stones in the main creek consist of brittle white and blue reef-quartz, characteristicly pearly and lustrous, frequently slightly amethystine, smoky and clear quartz crystals, some originally of very large size. Many of the stones exhibited evidence of "vug" origin, others magmatic segre-

gations in the granite mass. Other large pieces contain veins of greisen, revealing an association and structure similar to the tin and wolfram veins of Sugarloaf Mountain within the watershed.

Narrow veins of bluish-white quartz traverse the aplite at several points, striking, approximately, north-west, similar to veins observed crossing the Stanthorpe-road half-way between Wilson's Downfall and Amosfield.

Dredging has not yet been attempted in this stream above Wilson's Downfall, but several leases (M.Ls. 26 to 30) have recently been taken up for that purpose.

The absence of an adequate water supply is the drawback.

Owing to the thickness of the overburden much of the original mining took the form of drives into the banks from the main channel and shallow shafts in the banks, with the result that much apparently virgin ground has in reality been more or less worked out below.

A small amount of tin was won from Buckingham Gully, which joins the main creek in M.L. 27. Parish Ruby.

Wylie Creek (known as Wilson's Downfall Creek above road crossing at the village of Wilson's Downfall). This stream has a northerly course through the Parish of Wylie, County Buller, and has been one of the main centres of tin mining activity in the district. Operations began about the beginning of 1872, and have been continuously carried on up to the present, when dredging is the special feature. (See under Dredging.)

The principal tin-producing sluicing claims along this stream in the early days of mining, were the following in order down-stream from Wilson's Downfall:—

Graham's Claim, M.L. 3.
Roper's Claim, just below Anderson's Gully, on left bank of creek.
Flannery's Claim, on right bank of creek, mostly in M.L. 1.
Ransome's Claim, adjoining Flannery's, down-stream.
P. S. Dillon's Claim, mostly in M.L. 312.
Grant's Claim, in M.L. 319.
Christian's Claim, in M. Ls. 321-323.

A considerable amount of black sand occurred with the tin throughout these claims.

Some miles further down-stream, near corner of Portions 11, 12, Parish Wylie, J. Carmichael in 1888-9 obtained a small amount of fine water-worn tin, the sinking being 20 feet.

A very little fine tin was also obtained in Portion 13, above the Falls, by J. Pascoe, about 1892, near the junction of Middle Creek.

A narrow alluvial flat occurs along Wylie Creek, from Portion 11 to the junction with Maryland River; a dredging lease—M.L. 320—was taken up with the intention of working it, but boring operations failing to reveal tin in payable proportion, the lease was abandoned.

On M.L. 312 the New Wylie Creek Tin-dredging Company obtained topazes, sapphires, zircons, a number of coarse angular specks of gold, and a few tiny specks of a platinoid (?) metal, when cleaning the tin in a Willoughby machine. Insignificant quantities of gold have been recovered from the creek, downstream from M.L. 312; it is noticeable wherever the granite becomes very ferruginous, as at Cemetery Creek.

Between Wilson's Downfall and the junction with Maryland River, a distance of 12 miles, there is a fall of 800 feet.

Tin Lodes.

No payable tin lodes have yet been discovered in the Wilson's Downfal. Division, and the probabilities of discovery are very remote. Numerous thin veins occur on the falls of the Main Dividing (Macpherson) Range, in which tin and wolfram, in one instance molybdenite also occur; but they are individually too thin and too separate to be remuneratively worked. The tin oxide, moreover, is too leanly distributed even in the best of them. From this source the neighbouring drainage channels, or leads, have derived their valuable contents by natural denudation and gravity sluicing. The payable tin drifts in the beds of the streams represent the natural concentration of the tinstone from an enormous amount of material weathered from the granite containing the thin stanniferous veins.

The exceeding richness of some of those channels are thus criteria of the amount of denudation or degradation of the country, rather than of original richness of the tin veins.

The stanniferous lodes usually consist either of quartz, or quartz and secondary mica, in the form of greisen.

A few have been opened up to a slight extent, but the results did not encourage further effort. Occasionally—as at the head of Ruby Creek—thin veins have been disclosed by sluicing operations exposing the bed-rock. Some interesting jointings in the aplite show partial filling, tin crystals being attached to the walls, and the interstices only partly filled by incipient quartz crystals.

The earliest official references to tin lodes in this Division occur in the following quotations:—

> In 1882 Mr. H. Y. L. Brown, Geological Surveyor, reported—"Quartz veins are met with in the vicinity of the main range and elsewhere. About a quarter of a mile north-west of the Sugarloaf there is a shaft 14 to 15 feet deep in decomposed granite and thin quartz veins, containing tin ore, the strike being north-east and south-west. Further northward a large quartz reef outcrops with a similar strike, it contains molybdenite and pyrites. Tin ore attached to quartz is common in the alluvial drift here, indicating proximity of a lode. Dykes and veins containing tin ore have recently been discovered at the head of Herding-yard Creek. These deposits partake of the nature of lodes and dykes, the formation consisting of quartz, micaceous granite, micaceous quartz, &c., with crevices and cavities, containing smoky quartz crystals. They occur in a belt of four or five, striking from north-east to south-west across the range, and are enclosed in granite with an elvan porphyry dyke on the south-east, running parallel to them. Shafts have been sunk to a depth of 10 to 15 feet. . . . . The ore is disseminated through the micaceous quartz and micaceous granite, and on the faces of the crystalised quartz veins."*

In the same year the Mining Registrar recorded that Messrs. Funnell and Oldie had succeeded in finding a very good prospect at the head of Herding-rd Creek, which they secured by lease. They have found several veins or aders of stone carrying splendid ore.† Doubtless this discovery is identical th that referred to above in Mr. Brown's report.

Butler's Nob.—Portion 9, Parish Wylie, County Buller; 11 miles north Wilson's Downfall, on range between Wylie Creek and Maryland River.

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* Ann. Rept. Dept. Mines for 1882, p. 149. † *Ibid*, p. 96.

A small quartz vein, carrying a little tin stone, was discovered here abou 1890. A shallow trench, a few feet in length, was all the proving done, th prospects not being encouraging. Strike east and west in aplite.

Cosgrove's Wolfram and Tin Lode.—Parish Ruby, County Buller, betwee Dixon's Gully and Mosman's Gully, 6 miles N.W. of Wilson's Downfall Discovered by T. Cosgrove about June, 1907, and worked for about a yea Consists of a large quartz "blow" with a few scattered plates of wolfram A more granitic eastern lode contains wolfram in larger proportion, severa tons of wolfram concentrates being obtained from it by roasting, spalling and jigging in a small extemporised jig.

Alongside the East Lode a tin lode was followed for about 20 feet, 3 cwt of dressed ore being obtained.

Lode Hill Tin and Wolfram Lodes.—M.Ls. 21–22, Parish Ruby, Count Buller, on the Queensland border, 3½ W.N.W. of Wilson's Downfal Country coarse acid granite with aplite dykes, traversed by numerou small quartz and micaceous bands, carrying tinstone and wolfram occasionall in payable proportion. Most of these strike N.E. They vary in thickne from a knife-edge to 3 feet. The lode matrix being quartz and micaceou granite, the former frequently beautifully crystallized. From one flat vein few inches thick, 3 tons of coarsely crystallized tinstone were obtaine From this tract a large amount of the stream tin obtained in adjacent alluvi deposits has been derived.

McAlister's Wolfram and Tin Lode.—Parish Ruby, County Buller, at th head of Herding Yard Creek, close to the Queensland Border. Discover about 1906, by S. McAlister, and worked for a few months. Strike, N. 80° Dip slight to west, in coarse biotite granite. Wolfram is the chief metall ore, but a little coarsely crystallised tinstone occurs at the base of quar crystals in the lode, especially at west end of workings. Opened by trenc for about 1½ chains to a depth of 8 feet.

Sampson and Cokehill's Tin Lodes.—M.L. 21, Parish Ruby, County Bulle 3½ miles W.N.W. of Wilson's Downfall, on Lode Hill, close to Queenslan Border.

Discovered about 1880, when a considerable amount of work was don including shafts to 70 and 90 feet, with some driving and trenching, b only a small quantity of tin ore was obtained.

In 1907 Messrs. Sampson and Cokehill received aid from the Prospecti Vote to sink in micaceous granite, carrying thin veins of blue quartz (on t report of Mr. E. F. Pittman, Government Geologist), near the N.W. corn of M.L. 21, the country being coarse acid granite and aplite. Strike formation, N. 80, E., width 2 ft. 6 in. at surface, tapering out with dept At 16 feet in the shaft, it is much disturbed, no defined ore body being see Abandoned without completing aid granted, prospects being discouraging.

(*e*)—Barrier Ranges.

The great importance of the Barrier Mining Field recalls a prediction the Rev. W. B. Clarke in 1872, before any minerals had been discovered i that distant part of the State.* In his address to the Royal Society of Ne South Wales Mr. Clarke stated† :—

> "The Courtundie and Malia, and Coonbaralba Ranges of the Barri will, it is presumed, some day furnish their quota to the general fund mineral wealth.

* J. B. Jaquet, however, believes that Prospecting for copper was carried on at Piesse's Nob, some ti between 1867 and 1876. (Memoirs Geol. Survey, N. S. Wales, No. 5, 1894, p. 5.) † Trans. R. Soc. N. Wales, 1872, p. 34.

"Some years ago, in compliance with a suggestion of my own, a search for gold was instituted on the Barrier, but the season was unfavourable, and it was not successful. I am, nevertheless, of opinion that there are indications of metallic wealth in that rocky region which will be hereafter turned to good account."

J. B. Jaquet records a disastrous gold rush from Burra Burra in S.A. to this region in 1867.*

Silver-lead was discovered at Thackaringa in 1876, where prospecting was renewed in 1880. A rush ensued in 1882, culminating in the discovery of the famous Broken Hill lode in September, 1883.

The first reference to the occurrence of tin ore in this portion of the State is probably that by H. Y. L. Brown, now Government Geologist of South Australia, in a report on the Albert Goldfield in 1881, in his capacity of Geological Surveyor :—

"The granite diggings, which are the most extensive on this field [Mount Brown—J.E.C.] occupy a flat area of alluvial ground on the patch of granite which forms the centre of the Whittabrenah Range. The sinking is from 1 to 3 feet in a red alluvium, with round quartz gravel, and extends over a wide flat with little water courses, in the loose sand of which gold is found. The gold here is finer than that found elsewhere, as is generally the case in granite country, but is coarse enough to be seen sometimes in the dirt as it is dug.

"Tin ore (oxide) is found associated with the gold in the Prospectors' claim, but only in small quantity."†

Attention was first directed to tin ore on the Barrier in 1884 by the prospecting operations of Ralph Hodgson, John March, and Henry Hines, who applied for a lease of 40 acres (Application 358, Silverton) on the Euriowie Pastoral Holding, in Parish Byjerkerno, County Farnell, having taken possession on the 28th June, 1884. This block was surveyed September 2nd, 1884 as M.L. 1, the deposit in it becoming known subsequently as the "Caloola."

The second portion—M.L. 2—adjoining on the south, was taken up by Tucker and Co. and T. De Courcy Browne on the 9th August, 1884, and surveyed on same date as above lease.

In 1884 C. S. Wilkinson reported:—

"Sixteen miles N.E. from Poolamacca, and near the Euriowie Gap, the schist rocks are traversed by large masses and dykes of pegmatite granite. In one of these dykes, from 1 to 5 feet wide, Messrs. R. Hodgson and J. March have found tin ore. The ore occurs in detached crystals through the granite, which consists for the most part of white pearly mica, with quartz and a little orthoclase felspar. The prospecting shaft is 7 feet deep. The lode or dyke strikes E. 35° N. at 75°, and can be traced for about 10 chains, but only showing tin ore in a few places.

"About 60 chains N. 10° E. from here a similar micaceous tin-bearing dyke has been opened by Messrs. T. Murray and W. Brooks. It strikes N. 30° W., with a winding course of 15 chains, and varies in thickness from 1 to 6 feet; the tin ore appears to be only in patches in it. Within 6 chains are two smaller lodes of the same character. One of these has been sunk upon to a depth of 10 feet. It dips E. 35° N. at 85°, and is

* Memoirs Geol. Survey, No. 5, 1894, p. 3. † Report upon the Albert Goldfield, &c., N. S. Wales Legislative Assembly Papers, 1881, p. 4. By authority.

3 feet 3 inches thick; the tin ore in black crystals occurs chiefly near the hanging wall. In the schist, and 18 inches from the footwall there is a vein 4 inches thick, of ferruginous graphite."

"This locality deserves further prospecting, for I have no doubt that other deposits of tin ore occur in some of the numerous granite dykes."*

Little work, however, was done in 1885, the reported cause being lack of water for domestic purposes. Several leases were executed in 1886, on which prospecting was in progress. Little ore so far had been raised, the total dispatched amounting only to 2 tons 1 cwt., valued at £69, which apparently was not entered in the Customs.

During 1887 there was a very large increase in mineral lease applications. During this year the Writer made a brief visit to the field. The inevitable results of the prevailing boom were even then evident. Market manipulation of shares conveyed an inflated idea of values, which resulted disastrously for investors.

The town of Euriowie was established in the centre of the most promising mine holdings. Two banks were opened, six hotels, numerous stores, and a police station; the population numbering 500 at the close of the year.

In 1887 Mr. Wilkinson paid another visit and reported:—

"I also inspected the principal tin-bearing lodes found at Caloola, Euriowie, and Waukeroo, in the Barrier Ranges. These so-called lodes are intrusive dykes of granite in the slate formation, and, with the exception of a few, the tin ore is too much scattered through the dyke stone to allow the ground to be systematically mined by large companies. Nevertheless, tributors, or small parties of miners whose labour is their capital, a large quantity of tin ore will be raised and exported from this field."†

"The tin-bearing rocks have been proved over an extent of country about 28 miles long, in a N.N.W. direction, and 3 miles wide, but are likely to be found over a much wider area; for the same formations are seen throughout the greater part of the Barrier Ranges as far south as Thackaringa."

"These formations consist of metamorphosed clay slates and mica schists, intersected by dykes of granite and quartz reefs, The tin ore, cassiterite, occurs in the granite dykes, not as veins, but in black crystals, in size from a mere speck or grain, hardly visible to the naked eye, up to about 3 inches in diameter.

"It is not usually disseminated through the granite, but is distributed in patches, with a little ore scattered between them. In fact the cassiterite appears crystallized like the minerals composing the rock—quartz, felspar, and mica—which also often occur separately, or together, in coarsely crystalline patches in a fine-grained base of the same minerals. Sometimes one or more of these minerals predominate, so that in places the rock is chiefly composed of mica in large plates, or of mica and quartz, or mica and felspar, with crystals of tin-ore and black tourmaline intermixed. The granite dykes themselves are very irregular in thickness and extent, either in length or depth. In some instances, as at Lake's Camp, they suddenly widen out for 100 feet or more across, in others they divide into branches, or form small oblong or boat-shaped masses."‡

* Report on Silver-bearing Lodes of the Barrier Ranges, 1884, pp. 10, 11. † Ann. Rept. Dept. Mines N. S. Wales for 1887, p. 138. ‡ *Ibid* p. 141.

In summarising his completed examination of the stanniferous localities, Mr. Wilkinson stated :—

"From the above references it will be seen that the tin-bearing granite dykes, or so-called tin lodes, present more or less the same features, and from the irregular mode of occurrence, both of the lodes, and of the tin in them, may be inferred how uncertain must be their productiveness; therefore much prospecting will be required to prove their value. But as the lodes are numerous, there can be no doubt that considerable quantities of tin ore will from time to time be raised in working the bunchy portions of them."*

The "boom" was of brief duration, for in 1888 W. H. J. Slee, reported hat "the Barrier Ranges tin lodes were almost deserted during the year. This is principally due through some of the shoots and lenticular blocks containing the tin ore not being extensive enough to be worked with payable esults."†

During 1889, 13 tons 11 cwt. of tin ore were entered in the Customs as rom the Broken Hill District.

In 1890 the Warden reported :—

"That prospecting for tin had lately received an impetus in the neighbourhood of Euriowie, where payable tin ore was being raised by various parties, notably the Wheal Byjerkerno Company, who have 150 tons at grass, and are arranging for purchase of machinery to develop their property."

Notwithstanding the revival and applications to lease about 2,400 acres eceived during the year, there was no export of ore in that year nor the ollowing.

During 1892 the Mt. Euriowie Company carried on prospecting operations, lso the Wheal Byjerkerno, but the export was only 3 tons.

In 1903 a little work was done on several lodes with very indifferent results. . B. Jaquet visited both Euriowie and Waukeroo this year and recorded his pinion in the following terms‡ :—

"At the present time only a few miners are engaged at Euriowie, and the Waukeroo field is completely deserted. The first mentioned field was at one time being vigorously prospected, and altogether about 100 tons of partly dressed ore have been dispatched from it; but the latter, although a large number of mineral leases were applied for, never had much work performed upon it."

"The tin ore occurs in coarsely crystalline dykes (?) of granite and greisen, which intrude micaceous and talcose schists and gneiss. At both localities the tin-bearing schists form a narrow strip of country, intervening between a large mass of granite and, comparatively speaking, unaltered slates. At Euriowie there is a sudden passage from the perfectly crystalline schists, &c., but at Waukeroo the transition is a more gradual one—the crystalline schists by degrees pass into micaceous slates, and these again into indurated dark blue slates.

"The dykes (lodes) in which the tin occurs vary in width from 1 up to 20 feet, and trend between N.W. and N., they invariably have an almost vertical dip. When traced along their outcrops they are found to be subject to sudden variation in width, and to terminate often almost abruptly. In every instance where the mine workings enabled me to examine the end of one of the dykes below, I found it possessed a rounded end.

Ann. Rept. Dept. Mines for 1887, p. 143. † *Ibid*, 1888, p. 131. ‡ Ann. Rept. Dept. Mines for 1890, p. 126.

"The crystals of cassiterite vary in diameter from a small fraction of an inch to 2 or 3 inches; they are not evenly distributed throughout the 'lodes,' but occur in bunches. None of these bunches at present discovered have possessed large dimensions. As to the amount of tin which any of the lodes are likely to yield, no definite information can be given, for the bunches of ore are not evenly distributed through the lodes, or the cassiterite through the bunches. Exploration of the bunches in the past, however, has shown them to contain from 3 to 14 per cent. of tin.

"An examination of the mines enumerated above, and consideration of the geological features prevailing on the tin-fields, has made me of opinion that the tin-bearing dykes are likely to extend to great depths; but there is no reason why the size or number of the ore bodies should increase as a greater depth is reached."*

During 1894 26 tons of tin ore were dispatched from the local tinfields Operations were evidently at a standstill from 1895 to 1898, the only export being 4 cwt. in 1895 and 1 ton in 1898, though a number of leases were repegged during 1898. During 1899 and 1900 10 tons of ore were exported. An attempted flotation in London in 1899 failed. The only work carried on in 1901 was at the Wheal Byjerkerno, where some twelve men were employed. This year the field was visited by E. F. Pittman, who entertained a more favourable opinion of its possibilities than previous observers, and regarded the abandonment of the mines as, to some extent, due to ill-directed efforts, aggravated by long team carriage to rail, and the low price of the metal. Mr. Pittman's views are embodied in the following summary :—

"At the present time tin is materially higher, and there is a railway from Tarrawingee to the sea-coast, so that the ore or concentrates would only have to be carried by wagons for a maximum distance of 10 or 15 miles. Under the circumstances I am of opinion that some of these mines should be payable if worked on commercial principles. The ore presents no special difficulties in the way of extraction or concentration, and the tinstone is clean and eminently suitable for economic smelting. The topography of the country is specially favourable for the conservation of water, for there are rocky gullies in which large dams could be constructed in proximity to most of the largest tin-bearing dykes. The only point on which further information is required is the extent of the chutes of payable ore—in other words, there has not been sufficient systematic developmental work to warrant the erection of machinery in the majorlty of cases."†

In 1902 there was a slight revival at Euriowie and Waukeroo, twenty leases, aggregating 771 acres, being applied for, and additional treatment plant erected, nineteen and a quarter tons of tin ore being exported.

In 1903, mining was restricted to Euriowie, and to the efforts of Messrs. J. W. Brougham and W. Riechers, who carried on operations at the end of the year, and established concentrating machinery valued at £2,000 The ore dispatched amounted to 27 tons 9 cwt., followed by 7 tons 7 cwt. in 1904, and 2 tons 8 cwt. in 1905. In the latter year Mr. Brougham is reported to have raised 300 tons of lodestuff, but was unable to treat it owing to shortness of water.

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*Memoirs Geol. Survey, N. S. Wales, Geol. No. 5, 1894, pp. 128–131.
†Ann. Rept. Dept. Mines for 1901, p. 159.

Prospecting was in progress at both Euriowie and Waukeroo during 1906, but evidently the success was very moderate, the export for the year being but 13 tons 5 cwt.

Mining Inspectors Carthew and Sawyer reported that the lode in Riecher's claim at Euriowie (Block 30) had been proved 50 feet below the old workings, or about 135 feet as well-defined, and averaging 1½ to 2 feet in width, but tin contents were low at point of intersection.

In 1907 this mine was closed down, and the field apparently deserted. Two tons 18 cwt. of tin ore was the total export from the district during 1907, since then only a ten-ton trial parcel of picked—but unconcentrated—ore from the recent find at Kantappa has been dispatched in 1908. When the Writer visited the Barrier in October, 1909, two men were prospecting the Kantappa lodes, a couple were engaged in "specking" for slugs of shed tin at Euriowie; and Mr. Reichers was again preparing to attack the Wheal Byjerkerno lode, a four-head prospecting battery, and a Wilfley table being projected in connection therewith.

The total output from the Barrier Tin-fields from the date of opening until 1909, is shown in the following return furnished by the Collector of Customs, South Australia, by direction of the Comptroller-General. The figures represent the transfers of tin ore from New South Wales, and are believed to be wholly from Broken Hill.

Year.	Quantity.		Declared Value.
	ton.	cwt.	£
1886	.....		.....
1887	6	0	149
1888	27	11	693
1889	13	11	161
1890	.....		.....
1891	.....		.....
1892	3	0	60
1893	0	9	15
1894	26	0	1,180
1895	0	4	2
1896	.....		.....
1897	.....		.....
1898	1	0	30
1899	5	0	270
1900	5	0	237
1901	8	0	173
1902	19	5	997
1903	27	9	1,761
1904	7	7	545
1905	2	8	180
1906	13	5	41
1907	2	18	269
1908	.....		.....
1909	10	0	.....
1910*	4	10	450
Total	182	17	6,813

The great variation in proportional value of the yearly export is doubtless attributable to defective grading or concentration rather than market fluctuation.

The Writer visited the Euriowie field, as before stated, in 1887, during the height of the boom; in October, 1909, it was again examined, likewise Waukeroo, and the most recent discovery at Kantappa, on Corona Pastoral

* Approximate tonnage and value from Departmental return

Holding. The doubt entertained after the first inspection of the possibility of profitable enterprise has deepened in the light of further experience, after the lapse of ten years. Sufficient development has taken place to confirm the impression conveyed by the outcrops, that the tin-bearing portions of the dykes are too scattered, and too small, to repay the inevitable cost of discovery. In other words, the cost of dead or unremunerative labour involved in sinking and driving between the pay shoots entirely outweighs the value of the latter.

A very large amount of capital has been fruitlessly expended, yet the total output of tin ore, of varying degrees of concentration, from the date of discovery in 1884 to the end of 1910 only amounted to 182 tons 17 cwt. The Inspector of Mines reported the Euriowie and Waukeroo tin-fields to be practically deserted in 1909.*

The latest attempt to work on a commercial scale, by Mr. J. W. Brougham, in 1903–4, with the Euriowie Crushing and Concentrating Plant (consisting of rolls, jigs, and Wilfley table), resulted in an average return of less than a half per cent. from the best average lodestuff from several of the principal mines. The yield was reported to be from several thousand tons and may be accepted as a correct indication of value.

Nothwithstanding the increased advantages accruing from the proximity of railway transport, as pointed out by Mr. E. F. Pittman, this region remains seriously handicapped by scanty rainfall and timber supply. The great dearth of useful timber is in itself a serious disability, even for fuel purposes the supply is altogether inadequate, and is rapidly diminishing under the demands of Broken Hill for firewood.

Under natural conditions the level country is treeless, whilst the stony ranges of the Barrier are but lightly clad with very stunted mulga (*Acacia aneura*). Two eucalypts are noticeable—the larger, *E. rostrata*, fringes the sand-filled water-courses, affording luxurious shade, but gnarled and stunted boles of no value for building or other purposes. The smaller variety, *E. oleosa*, grows at the head of the watercourses in the stony habitat, and partaking somewhat of the mallee habit is of little service.

The nature and mode of occurrence of the tin-bearing dykes have already been recorded in the references quoted from previous writers. In addition, however, to the formations already noted, with the schists and gneissic rocks intruded by the stanniferous pegmatitic dykes, are included massive quartzitic conglomerates, limy schists, and graphitic slates. The limy bands passing into fairly pure limestone at Tarrawingee where it was quarried as flux during smelting operations at Broken Hill.

The Tarrawingee limestone is thoroughly crystalline and bears the appearance of chemical rather than organic origin.

The conglomerates—especially at Wheal Byjerkerno—are particularly massive and highly silicated by secondary silification. Huge inclusions of similarly silicated sandstones (or quartzite) occur at intervals in the schists. Large outcrops or "blows" of barren white quartz also occur in the latter and the dykes.

Geology.—Absence of fossils in the oldest stratified rocks of the Barrier—at least so far as investigation has proceeded—has necessitated provisional correlation. C. S. Wilkinson regarded them as Lower Silurian, or still older.† H. Y. L. Brown, writing of similar formations further north at Mt. Brown, inclined to Lower Silurian.‡

* Ann. Rept., Dept. Mines for 1909, p. 105. † Ann. Rept. Dept. Mines for 1884, p. 147.
‡ Rept. on Albert Goldfield. Parliamentary Paper, 4th Nov. 1881.

J. B. Jaquet classified the oldest Broken Hill rocks as Silurian.*

Recently Dr. Douglas Mawson, Lecturer in Mineralogy at the Adelaide University, identified the Poolamacca and Euriowie formations as equivalents of the Lower Cambrian of South Australia, in which remarkable evidence of glaciation exists, and later discovered an unconformity between these strata and the underlying Broken Hill schists, which he regards as Pre-Cambrian.

Dr. Mawson is making a special study of the geology of the Barrier and his conclusions will be awaited with interest.

The association of cassiterite with coarse pegmatites in the Barrier Ranges tin-fields and at Toonallook, near Germanton, recalls similar occurrences in the Northern Territory, in the Black Hills of Dakota, United States, and in the Transvaal.

The Harney Peak tin occurrence of Dakota has been described by W. P. Blake :—"The granite masses, especially those on the confines of the granitic area, are remarkable for the extreme coarseness of their crystallization, the constituent minerals being very large and separately segregated. Large masses of pure quartz are found in one place, and masses of felspar in another ; and the mica is often accumulated together, instead of being regularly disseminated throughout the mass. The surrounding schists are not greatly metamorphosed from their original condition, and the transition from coarse granite to schist is sudden."†

The Transvaal occurrence has been described by Kynaston and Mellor‡ :—

> "The frequent occurrence of cassiterite in the granite areas of the Waterberg tin-fields, in association with coarse pegmatites and quartz bodies, has recently attracted the attention of both the prospector and the geologist. The cassiterite is often in large crystals, but as a rule these occurrences are very patchy, unreliable, and unprofitable to work ; and only in a few instances, such as that on Roodepoort, and the 'Kitchen Reef' in Groenvlei, have any rich deposits of ore been found in the pegmatites, and even in these cases they are apparently not persistent. . . . . Pegmatites in general are, doubtless, one of the very latest segregations from granitic magmas, and the occasional occurrence in them of cassiterite and many of the rarer minerals is to be explained, according to Brögger and others, by the concentration of the escaping volatile components of fluorine, boron, &c., into the smaller volume of the residual magma from which the pegmatite consolidated.
>
> "The pegmatites often contain a very high percentage of quartz relatively to felspar, and graduate into quartz veins with only a very small proportion of felspar. Cassiterite in small quantities is often associated with altered and brecciated masses of the latter type, and has often formed about the edges of the quartz crystals, even when lying scattered in a highly altered and mineralized matrix, suggests that they originally formed portions of hollow quartz-veins or vughs, and the actual occurrence of cassiterite on the faces of quartz crystals lining vughs seems to support this."‡

The accompanying descriptive notes on the various lodes opened are largely from reports made by previous investigators when work was in progress. The Barrier tin-mining industry being practically defunct, the Writer's inspection in 1909, for the purpose of noting progress since the previous examination of 1887, was, perforce, limited to surface works, such as open-cuts, costeens, &c.

In the descriptions of individual occurrences, however, are embodied all the facts recorded by previous writers.

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* Memoirs Geol. Survey, N. S. Wales, No. 5, 1894, p. 37. † Eng. and Min. Journ., 1892, p. 512.
‡ Geol. Survey Transvaal, Mem. No. 4, 1909, p. 104.

Alberta Lode.—(See Kantappa).

Albion Lodes.—Portion 95, Parish Waukeroo, County Yancowinna. On south side of Yancowinna Creek. Described by C. S. Wilkinson* as dipping W. 25° N. at 80°, in coarse crystalline granite traversing altered slate. Shaft, 22 feet deep. One hundred feet south a cutting exposed the lode 7 feet wide, with small patch of tin ore in centre.

Near the S.W. corner of Portion 95, another lode, 25 feet wide, carried a little tin and tourmaline.

Within 10 chains east are several other lodes—one, from 1 to 2 feet thick, containing a little tin and garnet; strike, N. 40° E., in chloritic slate.

Badjerrigarn Lodes.—MLs. 40–43. Parish Byjerkerno, County Farnell. J. B. Jaquet described the deposits in these leases as a succession of granitic dykes, which, if explored, might yield bunches of tin ore. On M.L. 40, a shaft had been sunk 60 feet, but no tin ore was discovered in it.†

Barrier Bischoff Lodes.—M.L. 8. Parish Byjerkerno, County Farnell. The same authority described these occurrences:—

> "The eastern lode running through these leases is about 30 feet wide. It has been opened by means of a quarry from the hill side, and a considerable amount of rock broken down; but neither in the faces of the quarry nor in the displaced rock could I see any tin. A western lode has been cut by means of a tunnel driven in from the hillside, and by a shaft, no tin ore, however, was found in it. At one spot on the outcrop of the western lode a bunch of ore occurred, which disappeared when a depth of nine feet had been reached." (*Ibid.*)

Block 30 *Lode.*—Parish Byjerkerno, County Farnell, Euriowie. Strike N. 25° W. Granite dyke opened by one vertical and one underlay shaft to a depth of 135 feet. Width, 6 inches to 2 feet, in hard quartzitic country. Tin showing at shaft.

Bischoff Lode.—Parish Byjerkerno, County Farnell, Euriowie. C. S. Wilkinson in 1887 described this lode as 7 feet wide, striking N. 25° W., and containing some coarse crystals of cassiterite. A few chains from it another granite dyke contained scattered crystals of tinstone and large masses of quartz.

Bunchekerno Lode, Euriowie.—Parish Byjerkerno, County Farnell. Granite dyke opened by shaft. Some fair ore raised and treated locally according to report.

Caloola Lode.—M.L. 1. Parish Byjerkerno, County Farnell. Taken possession of by the original prospectors of the field—R. Hodgson, John March, and Henry Hines—on the 28th June, 1884. Visited by C. S. Wilkinson in 1884‡, and again in 1887, when the following report was furnished:—

> "On the Caloola Company's lode a shaft has been sunk, following the lode to a depth of 75 feet, and showing it to be much the same character as near the surface. Some 8 tons of 50 per cent. ore have been raised during the sinking of this shaft. The lode or granite dyke dips E. 35° N. at 75°, it is from 1 to 9 feet wide, and outcrops on the surface for about 200 yards; the tin ore is in patches through it."§

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* Ann. Rept. Dept. Mines, 1887, p. 143. † Memoirs Geol. Survey N.S. Wales, No. 5, 1894, p. 131
‡ Report on the Silver-bearing lodes of the Barrier Ranges in the Albert District, N.S.W., 1884, p. 10
§ Ann. Rept. Dept. Mines for 1887, p. 142.

J. B. Jaquet visited the mine in 1894, and described developments to date, when it was being worked by the Euriowie Tin-mining Company :—

"A shaft has been sunk to a depth of 135 feet, in order to explore a lode running through M.L. 1, and having an average width of 4 feet. At a depth of 70 feet, a level has been driven south for a distance of 90 feet, and near the shaft a rich bunch of ore, 25 feet long, occurs, while along the whole length of the level scattered crystals of cassiterite can be seen. Other exploratory workings occur in this mine, but in none of them has any tin been found."*

In October, 1909, the Writer was informed by Mr. G. W. Grey, of Euriowie (an early resident of the field), that after the 1887 boom, about 30 tons of ore (dressed up to about 15 per cent.) were taken from this lode. Two shafts were sunk, about 60 feet apart, to 60 and 120 feet respectively. The former was driven north 100 feet at the 60 feet level, and the latter 60 feet at the 100 feet level. Tin ore continued down from the surface to 60 feet, and was stoped between shafts to the surface.

The lode was subsequently worked for a time by a miner named Lambie, and the output treated at the Mount Euriowie Battery, but particulars are not available.

Caloola South Lode.— Parish Byjerkerno, County Farnell. In this ground C. S. Wilkinson described two dykes of coarse grained granite, one 20 feet across, the other (70 feet east) 15 feet wide Two chains north they junctioned.

Consolidated Tin Lodes.—Parish Waukeroo, County Yancowinna, about 300 yards north of the original Waukeroo Prospecting Claim. In the former Mr. Wilkinson described :—

"A similar slate reef, with granite veins of irregular width up to 15 inches, has been opened to a depth of 6 feet, containing coarse tin in patches. Twenty feet from it, on the east side, is a large quartz reef three feet 6 inches wide and 70 feet long. Further east 100 feet, another granite dyke, 3 feet thick, would yield ore probably up to 2 per cent. ; but it could be sorted to a much higher yield."†

Cosmopolitan Lodes.—Portion 3, Parish Byjerkerno, County Farnell, described by Mr. Wilkinson as occurring about three quarters of a mile north-north-east of the Caloola, and of similar character.

Dolcoath Lode.—About a mile from Mount Lake. Described by the same authority in 1887, as :—

"A lode consisting chiefly of quartz, and varying in thickness up to 8 feet ; contains tin ore in patches which separately would yield about 30 per cent. ore. It strikes north 5° west, traversing altered slates. Twenty yards from it on the east side is another lode of lenticular bunches of quartz up to 2 feet thick, containing tin ore."‡

Euriowie.—
Euriowie North.—
Euriowie South.— } See Mount Euriowie.

Granite Springs Lodes.—Parish Waukeroo, County Yancowinna. Described by C. S. Wilkinson in the following terms :—

"Within a diameter of 3 chains are three lenticular granite dykes up to 4 feet thick, containing a little tin ore, about 2 per cent. Strike east-north-east, north-east, and north 5° east (same as strata) ; three

* Mem. Geol. Survey N. S. Wales, No. 5, 1894, p. 131. † Ann. Rept. Dept. Mines for 1887, p. 142.
‡ *Ibid.*, p. 142.

chains north are talcose slates like those in the Prospector's Mine, with quartz blows and fluor-spar; five chains further north is a lenticular granite lode 5 feet wide, showing a little tin, and near it a quartz reef containing wolfram. Three small lodes have also been prospected near the surface; they contain small quantities of tin ore in patches. A little stream tin ore was found near the head of a gully draining from them."*

Imperial Tin-mining Company.—Parish Waukeroo, County Yancowinna. In 1907, this Company did a considerable amount of prospecting on Blocks 18, 19, 73, and 75, in Waukeroo Paddock, but operations were suspended at the end of November, results not being sufficiently encouraging.

Jubilee Lodes.—Parish Byjerkerno, County Farnell, about 1 mile south-south-east from Calcola lode. Described by C. S. Wilkinson, in 1887, in the following terms:—

"One lode, 18 inches wide, but thinning out on the north end, consists chiefly of quartz and felspar, with but little mica. The tin ore occurs in patches containing about 10 per cent. of tin ore. Another granite lode, about two chains to the east, is 2 feet 6 inches wide, and has been opened for 6 feet from the surface; only a little tin ore is visible in it."†

Kantappa Lodes.—Parish Corona, County Farnell. On Corona Station, about 8 miles north-west of Thackaringa, and 1 mile from Alberta Creek.

Discovered by J. Fuller, and purchased by J. Burns in January, 1908.

Aid granted to sink on one lode for 60 feet, on report of Inspector Carthew (P.B. 09–306).

The accompanying plan shows juxtaposition of the tin-bearing dykes of pegmatite in schist at Kantappa. The tin ore is fairly well distributed in those portions in which it is visible at the surface; these, however, appear to be more or less patchy and isolated.

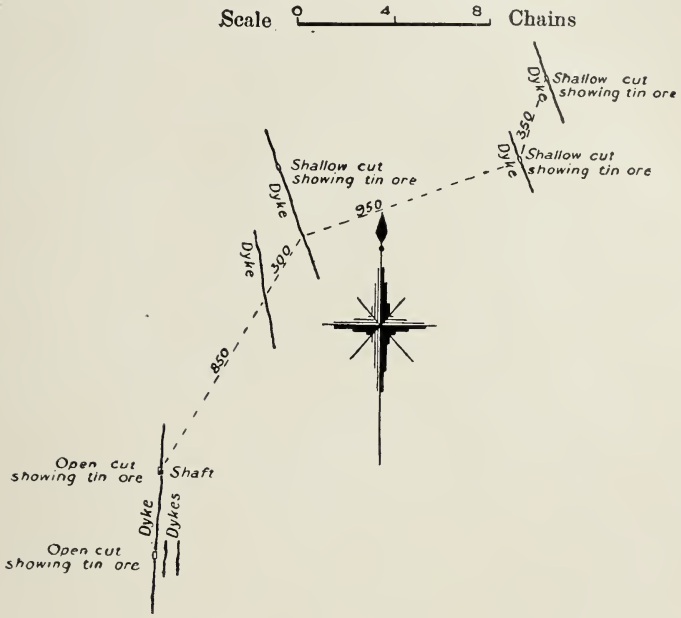
The greatest width observed in these intrusive masses was 12 feet, near the shaft in the westernmost. The others range from 1 to 8 feet in width, but do not make conspicuous outcrops in the level country in which they occur; occasionally not appearing above the general level.

A bunch of rich ore was extracted from a shallow cut in the western lode; but the shaft alongside at 32 feet (October, 1809), revealed none. Ten tons of picked ore from the open cut, sent to Adelaide, was crushed and concentrated in May Bros. jiggs, for a reported yield of 27 cwt. 2 qrs. 17 lb. of tin ore, averaging 66 per cent. of tin; equal to 13·8 per cent. cassiterite in the ore.

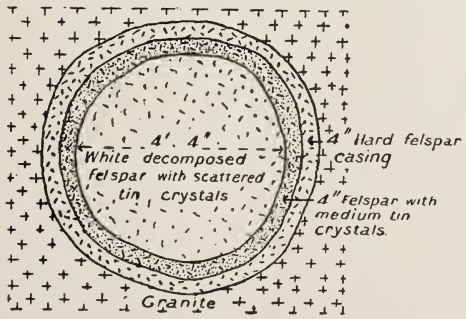
Lady Don Lode, Euriowie, Parish Byjerkerno, County Farnell. C. S. Wilkinson in 1887 described the tin-bearing dykes in this lease as being identical with the Sceptre dyke, which, however, divided into two in the former ground. One of these dykes, 12 feet thick, in the Lady Don Mine, "has been prospected by two tunnels, driven at different levels on the side of the slate hill. Tin ore is scarce in it, portions of it not showing any. I noticed a little fluorspar. The granite is composed of large crystalline masses of felspar, mica, and quartz; one patch of quartz at the surface is 10 feet wide. The dyke strikes north 10° west. About 4 chains easterly is another similar dyke, 4 to 15 feet wide, with a very irregular strike to the north-east."†

* Ann. Rept. Dept. Mines for 1887, pp. 142, 143. † *Ibid.*, p. 142.

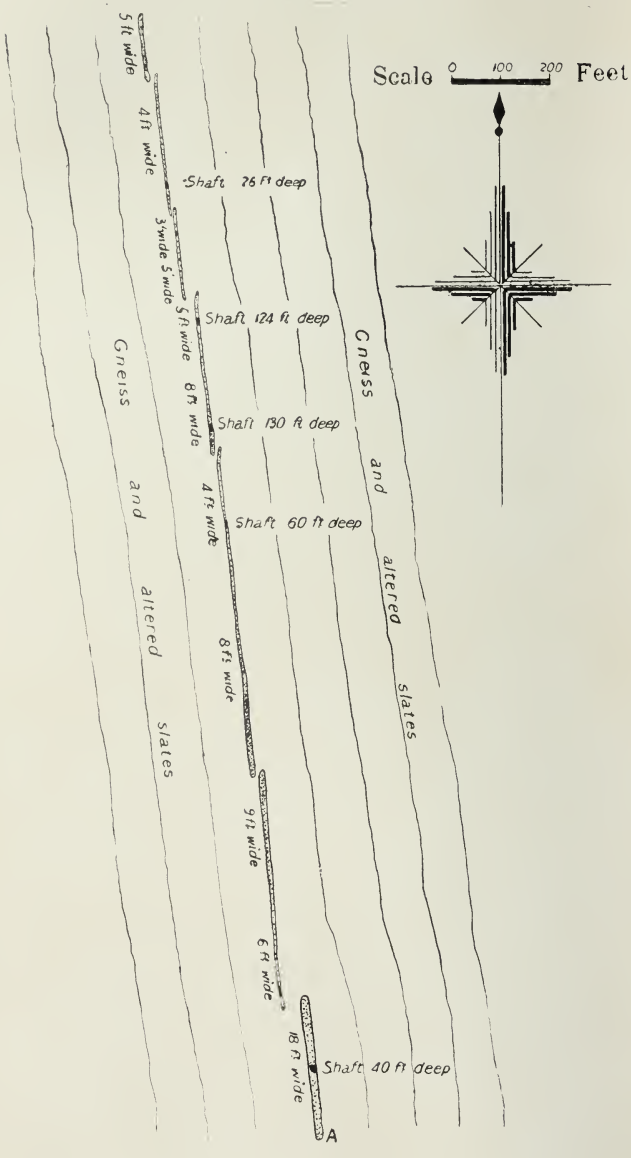
Plan of Kantappa Tin Lodes, Parish Corona, County Farnell.



Section of "Tin Pipe" worked in the Cricket Ground Lode in Litchfield's land, Parish Darby, County Hardinge. (See page 211.)



Mount Euriowie Lodes, Barrier Range (after J. B. Jaquet).



A treatment plant was erected at the Lady Don, consisting of breaker, rolls, jigs, and Wilfley table, but particulars of output are not available.

Mount Euriowie Lodes M.Ls. 12–14, Parish Byjerkerno, County Farnell. The lode or lodes at Mount Euriowie were described by C. S. Wilkinson, under the titles of Euriowie North and Euriowie South.

The principal developments have taken place in the North block, of which he wrote:—

> "One of the most regular lodes yet opened is that which runs for about half-a-mile through the Euriowie North portions. In this lode the tin ore is seen to be more regularly distributed through the granite than is usually the case. But even this lode, or granite dyke, which it really is, varies in width from 1 to 18 feet, and runs in breaks, thinning out at intervals and making again, within a few feet on the west side. (This feature is well illustrated in the following plan after J. B. Jaquet, J.E.C.) Nevertheless, the lode appears to be sufficiently persistent to be worked on a large scale.
>
> "I was informed that a parcel of 20 tons of it, crushed at the Umberumberka machine, yielded at the rate of 8 per cent. of tin oxide. The lode strikes north 13° west, and has a westerly dip. It consists of coarsely crystalline granite, with large flakes of mica, and traverses altered mica schists, which strike north and south. The same lode continues into the Euriowie South Company's ground.*"

In 1894, after a considerable amount of exploratory work had been performed, J. B. Jaquet inspected the development and reported :—

> "Mount Euriowie Mine has been exploited by means of five shafts, one of which has reached a depth of 124 feet, and several levels. The whole of the available ore would seem to have been exhausted before the mine ceased active operations; in none of the underground workings did I see any cassiterite. An expensive concentrating plant was erected during the early days of the field, but only small quantities of ore have been put through."†

Since that date, Mr. J. W. Brougham informed the Writer, several thousands of tons of lodestuff were put through the dressing plant from Mount Euriowie, and some of the other principal lodes, for an average yield of about one-half (0.5) per cent. of tin oxide. His experience confirms the previously expressed views of the patchy nature of ore occurrence. The crushing and concentrating plant consisted of breaker, rolls, jiggs, and a Wilfley table.

Mount Lake Lode, Barrier Ranges. C. S. Wilkinson, in 1887, described this occurrence as follows :—

> "At Mount Lake occurs a dyke mass of coarser-grained granite, suddenly widening out in one place to 100 feet; with very small tin crystals appearing here and there in it. A branch vein up to 6 feet thick, but pinching out in places, extends west 30° south from it for 4 chains, and shows coarse crystals of tin ore in places. Within 15 chains to the east are four other granite dykes and quartz reefs from 1 to 10 feet thick; they strike north-north-west, and have not yet been opened. Some small deposits of stream-tin are likely to be found in the alluvial flats between these hills, together with good soakage water. Similar tin-bearing granite dykes occur to the south in Kali's claim, and also beyond, in the Mount Lake south blocks; where there is one

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* *Ibid.*, p. 142. † Memoirs Geol. Survey N. S. Wales, 1894, No. 5, pp. 130-131.

showing coarse tin in patches, from which 50 per cent. ore might be picked; but the general average would not, I think, yield 4 per cent. of ore. It strikes N. 30° E. for about 8 chains, and varies in width up to 15 feet; but to the south it takes a more southerly course for about 200 yards, thinning out in places. There are other small lodes near on either side, and another 8 chains east is very felspathic; varying in width up to 30 feet, for about 120 yards, with small crystals of tin in patches. These lodes have only been opened 3 feet from the surface."*

Pine Paddock Lodes.—Parish Waukeroo, County Yancowinna. Of these C. S. Wilkinson wrote:—

"In the Pine Paddock Proprietary Company's leases are several tin bearing dykes of large-grained felspathic granite, traversing slate, and varying in thickness up to 10 feet; striking N. 5° W. to N. 20° E. Some are like short oblong or boat-shaped, dykes; the tin-ore with tourmaline occurs in patches, and would have to be sorted to yield 10 or 15 per cent. of ore."†

Prince of Wales and Queen Victoria United Lodes.—Parish Byjerkerno, County Farnell. In describing the Bischoff lode, C. S. Wilkinson wrote:—

"In the adjoining ground of the Queen Victoria and Prince of Wales United Company, a shaft has been put down on a granite dyke 40 feet wide, cropping out on the top of a range; a little tin-ore is seen in the stone. About 100 yards on the east side of it is another similar lode, 16 feet wide, dipping W.S.W. at 60°; the tin-ore is chiefly near the footwall, and on the west are two other lodes, one 52 feet wide dipping easterly and showing a little tin. The lodes consist of coarsely-crystalised granite, very felspathic, traversing altered schists; they vary in thickness, and in places thin out. But on the same line of strike, towards the south, other lodes crop out througth the Victory Company's ground."‡

Victory Lodes.—Portions 41 to 43, Parish Byjerkerno, County Farnell. Described by C. S. Wilkinson:—

When some of the lodes were being prospected, a shaft 40 feet deep had been sunk on one of them. This lode strikes N. 10° W., and consists of coarse crystals of felspar, mica, and quartz, with tin-ore in patches, which, if worked separately, would probably yield 20 per cent. of ore.§

The Writer ascertained locally that the main shaft was sunk 200 feet, and driven over 100 feet along the lode. Fifty to 100 tons of ore are reported to have been extracted, some of which was treated locally, the rest despatched.

Open cuts about 3 chains in length along the cap of the dyke failed to show any trace of tin-ore at the present time.

Sceptre Lode.—Parish Byjerkerno, County Farnell. Adjoining the Trident Mine. Examined by C. S. Wilkinson in 1887 when development was in progress:—

"In the next mine, the Sceptre, a similar granite dyke suddenly widens out to 100 feet at the surface. It contains large irregular patches of quartz, with chlorite, tourmaline, and crystals of tin-ore in

* Ann. Rept. Dept. Mines for 1887, p. 142. † *Ibid.*, p. 143. ‡ *Ibid.*, 1887, p. 142. § *Ibid.*

patches. Its general strike is N. 20° W., but to the south it divides into two branches, which, varying from 2 to 10 feet thick, continue into the Cobar Company's ground."*

An outcrop of similar character occurs on the east side of the dyke described above. Large "blows" of barren white quartz also occur

South Waukeroo Lode (described by C. S. Wilkinson).—Parish Waukeroo County Yancowinna.

"On the South Waukeroo Company's ground three lenticular granite dykes striking N. 5° W., and up to 4 feet thick, show coarse crystals of tin in patches, the whole, if taken out, would yield about 2 per cent. of ore."†

Thistle Lode.—Portion 6, Parish Byjerkerno, County Farnell.

"A lode having a width of 4 feet has been proved by a shaft to a depth of 125 feet, and some of the rock raised has yielded a little tin."‡

Trident Lodes.—M.L. 18. Parish Byjerkerno, County Farnell. The main workings are on part of the same large outcrop of coarse pegmatite as the Lady Don. Much of it consists of coarsely crystallised soft mica (muscovite), with quartz, felspar practically absent.

Examined by C. S. Wilkinson in 1887, who recorded that:—

"Here, within a width of 130 feet, the slate formation is traversed by several granite dykes, one 12 feet wide, very micaceous and quartzose in places, with coarse tin-crystals unevenly distributed. A shaft 60 feet deep has been sunk, and the shallow alluvial in a small gully draining from the lodes has been surfaced for a few yards, and several bags of shed tin obtained."§

Waukeroo Lodes, Parish Waukeroo, County Yancowinna. These lodes were examined by the same authority in 1887, shortly after their discovery; of the prospector's claim he wrote:—

"At the Waukeroo prospector's mine, several openings have been made along a singular outcrop of talcose schist for about 15 chains; it contains a little tin in crystals, and strikes north 5° west, with lenticular quartz veins 2 feet wide. Along its southern extension lenticular veins of granite, as well as of quartz up to 3 feet thick, occur.

"The patches of tin ore in the granite, if taken out separately, would yield from 20 to 30 per cent of tin oxide."‖

Wheal Byjerkerno Lode, M.L. 6, Parish Byjerkerno, County Farnell.

Under the name of "Huel Byjerkerno," J. B. Jaquet, in 1894, reported:—

"This mine was the only one upon which active work was going on at the time I visited the field. On the surface the outcrops of the "lodes" contain some rich bunches of ore, but the extent of these bunches has in no instance been proved.

"50-*foot level*.—Has been driven north, on the lode, for a distance of 190 feet. Near the shaft a mass of tin-bearing greisen, 25 feet long and 10 feet wide, occurred. About 30 feet distant from the shaft the lode "thins out" considerably, and beyond this point its width varies from 2 to 4 feet, while no tin is present.

100-*foot level*.—Has been driven 50 feet south and 20 feet north. At a distance of 15 feet south from the shaft the lode terminates, but the drive has been continued on an overlapping lode, which is about 4 feet wide, and contains small and not payable quantities of tin ore.

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* Ann. Rept. Dept. Mines for 1887, p. 142. † *Ibid.*, p. 143. ‡ J. B. Jaquet, Memoirs Geol. Survey N. S. Wales, No. 5, 1894, p. 131. § Ann. Rept. Dept. Mines for 1887, p. 142. ‖ *Ibid*, p. 142.

"200-*foot level*.—At this depth a cross-cut has been driven out from the shaft, and at a distance of 53 feet has struck the end of the overlapping lode met with in the level above. A short level has been driven on the lode, which is 4 feet wide, and a rich bunch of ore, 25 feet long, has been exposed. This bunch of ore only extends for a distance of 2 feet into the 'back' of the level, and it has yet to be proved how far it extends downwards."*

The Company erected a crushing and concentrating plant, consisting of breaker, rolls, and jigs, but the quantity treated in the aggregate did not amount to much. In 1909, Mr. W. Reichers was erecting a four-stamp battery (250-lb. stampers), with jigs and a Wilfley table, with a view of treating the remaining ore at grass, and further prospecting the lode meanwhile. The return for 1910 of tin ore so obtained was stated at £450.

On this lease a small quantity of loose "shed" tin ore was obtained from surfacing below Greenwood's shaft.

In October, 1910, aid was granted to drive a tunnel in a new lode in M.L. 5, Parish Byjerkerno, from the right bank of the creek of the same name. This tunnel will give about 80 feet of "backs."

Western Star Lode, Parish Waukeroo, County Yancowinna.—Examined by C. S. Wilkinson, in 1887, who reported:—

"A similar lode [to South Waukeroo—J.E.C.] 4 feet thick, and striking north 10° west traverses mica slates in the Western Star Mine.†

(*f*)—Southern Districts.

Albury Mining Division.

Toonallook Mine, Toonallook Station, near west boundary of Conditional Lease 1106, Parish Mullenjandra, County Goulburn, 15 miles south-south-west of Germanton.

Discovered by T. King about 1903; worked by him and A. N. Mitchell for about three years, during which the lode was opened on the crown of the hill to a depth of 80 feet; also by a 30-feet shaft, and several shallow costeens.

It is at present held by a syndicate (A. A. Blackman, trustee), which began operations about April, 1910, the principal effort being construction of a road of access. The lode material consists of coarse greisen (pegmatitic in places) with occasional aplite veins, intruding slate country. The feature of the lode is the abundance of large white mica plates, averaging about ½-inch square, which causes considerable difficulty in concentration.

The greisen is reported traceable for some distance in an easterly direction. The shoots of ore strike approximately east and west, and dip north at 1 in 60.

The slate has been altered to mica schist at the contact of the greisen, and in places chiastolite is developed, and numerous flakes of coarse white mica occur through the schist near its boundary. Veins of brittle white quartz—mostly narrow—traverse both greisen and slate. The average dip of the slates is N. 15° E. at 41°; but they are much disturbed by the intrusion. Narrow apophyses—usually finer-grained—extend from the greisen into the slates.

* Memoirs Geol. Survey N. S. Wales, No 5, 1894, p. 130. † Ann. Rept. Dept. Mines for 1887, p. 142.

Tin ore is said to occur from the surface to the bottom of the 80 feet shaft, also for a proved width of 15 feet in a crosscut from the shallow shaft. About 2 cwt. of very coarse black tin has been obtained by roasting and hand-crushing. About 1 ton of ore was being despatched to Sydney for experimental purposes, as regards concentration.

Very little tinstone has been shed owing to a thin covering of slate limiting the outcrop of the greisen.

Germanton Mining Division.

Basin Creek, rising near Mount Jergyle, in Parish Vautier, County Goulburn, about 14 miles south-easterly from Germanton, and flowing east, and then south to the Murray River.

Tin is reported to have been discovered near the head of this creek by A. H. McEachern in 1892, though its presence had been noted lower down its course at an earlier date. In this year also lode tin was reported in the same parish.*

In 1893 the Dora Dora Tin-mining Company constructed a dam to conserve water for sluicing purposes, and obtained an output of about 2 tons of stream tin per month from the head of Basin Creek.†

An Albury syndicate also carried on boring operations in this locality.

During 1894 the Dora Dora Company expended a considerable sum on wages, &c. The Champion Tin-mining Company constructed extensive fluming and a tail-race at the junction of Basin and Spring Creeks.

In this year the Writer visited the locality and examined the Dora Dora Mine, the only one then at work. The workings were then near the head of Basin Creek, on the western boundary of R. Bell's Conditional Lease.

The deposit of alluvial wash then being worked was originally opened by an Albury syndicate. A storage dam of about 1,000,000 gallons capacity had been constructed for sluicing purposes, but insufficient fall rendered the pressure inadequate for effective work, even when the supply was fairly abundant. During the greater part of the year, however, owing to the elevation of the site, water is very scarce. The wash averaged 6 inches in thickness, the tin ore resting directly on the granite bedrock. No lode had been discovered in the neighbourhood at this date, nor any lode specimens in the wash. Up to the date of the Writer's visit in April, 1904, about 10 tons of clean tin ore had been won from the workings, which extended about 200 yards along the bed of the stream; but as it was won at a financial loss, active work ceased about three months prior to the date mentioned.

The course of Basin Creek, between the mine and the Murray River, lies through private land, with the exception of about 1½ mile of rough precipitous country, through which the creek falls rapidly.

An attempt has been made to drain a long swamp in Portion 12, through which Basin Creek flows, but more extensive operations were necessary.

Below the mine tin ore was reported in Portions 25, 32, and 47. As will be seen, this portion of the creek's course received attention. The wet ground above the bar, represented by the rugged country, was also drained by a tail-race.

During 1900 the Basin Creek Tin-mining Company carried on prospecting operations for some months with a view of establishing a dredging plant. Stream tin to the value of £120 was obtained, but some difficulty was experienced with clay-beds.

* Ann. Rept. Dept. Mines for 1892, p. 43. † *Ibid.*, 1893, p. 42.

In 1905, the Talmalmo Tin-mining Company was formed to work the land formerly held by the Champion Tin-mining Company. A dredging plant was obtained from Messrs. Thompson & Co., of Castlemaine, with 12-inch nozzle, and 10-inch gravel, pumps. Work was continued until September, 1907, when the plant was closed down, the ground not proving payable.

In 1906 the Mount Pleasant Tin-mining Company also obtained a dredging plant of similar power from the same firm to operate the old Dora Dora site, but closed in October, 1907, having worked out the area. In 1908 the machinery was removed to Victoria.

The locality was visited by E. C. Saint-Smith, Field Assistant, in September-October, 1910, who noted the latest phase of the tin-mining industry for this work.

The average depth of the ground worked by the Mount Pleasant Company was about 8 feet, consisting of granite sand drift, with patches of bluish clay resting on 2 to 4 feet of coarse stony wash. The bedrock, soft rotten granite, was uneven. In places a little fine tin occurred through the overburden, especially where there was much sandy drift. Its occurrence in the wash was patchy—rich potholes, and frequent almost barren areas. The dressed tin ore was fine-grained and water-worn, black, ruby, resin, and grey coloured, and of high grade. Black sand was absent.

Between the site of the Company's operations and the rugged channel country mentioned, a small amount of sluicing has been carried out, and some tin obtained from isolated patches. Below the granite bar the stream opens out into a long extensive alluvial flat, known as Bell's Swamp, where operations were carried on by the Talmalmo Dredging Company in Portion 32, near the north boundary. Considerable difficulty is reported to have been experienced in dealing with the stiff clayey overburden.

The lower portion of Basin Creek, near the Albury-Jingellic road, is known as Bourke's Flat, and is of considerable extent. Here the Basin Creek Company concentrated its efforts, several bores and a number of shafts, ranging from 18 to 22 feet in depth, were put down. A little tin and gold were found in some of the tests. Six feet of stiff clay in the overburden was encountered, which is likely to militate against prospective dredging.

The Company deepened the creek channel 6 feet for the purpose of draining Basin Swamp, but nothing appears to have resulted.

Several tributaries of Basin Creek have been proved more or less stanniferous, the most important being Hell's Hole Creek, heading in the Mount Jergyle range about 2 miles south of the main stream; Salt-hide Creek, heading from the same range about 2½ miles south; and Sixpenny Creek, heading in Portion 55, Parish Vautier.

Tin is also reported in a small gully heading in Portion 17, but water is not available.

Mining operations have revealed numerous small stanniferous quartz veins in the creek bed, near its head; the country consists of schist, quartzite, and slate, intruded by acid granite, aplite, and quartz-porphyry.

Buckeen Creek.—A western tributary of Cockatoo Creek, heading in a high range north of Portion 60, Parish Talmalmo, County Goulburn; 16 miles south-east of Germanton.

This stream has been worked for a distance of 1½ miles in its upper portion. The channel is narrow, usually from 15 to 20 feet. Average depth of sinking 6 to 8 feet. Overburden—principally clay, with slate and schist fragments. Bedrock—slate; uneven, and traversed by hard bars.

Tin was discovered here in 1893 by A. H. McEachren ; patchy in occurrence, partly water-worn, coarse, and of grey colour. No black sand, Water only available during wet seasons.

About one quarter of a mile east a white quartz lode containing tinstone and mispickel, was opened by W. Woodlands about 1905, from which £20 worth of dressed tin was obtained ; reported to have pinched out.

Currajong Tin Mine.—Three miles east from Germanton, in Portion 198, Parish Germanton, County Goulburn ; in a right bank tributary of Ten-mile Creek, heading near south boundary of Portion 184.

Discovered by F. Heather, senior, about 1890, and worked intermittently since. Average depth, 6 feet. Overburden of granite sand resting on 2 feet 6 inches of coarse, angular, stony wash, with some water-worn pebbles. Average width, about 2 chains. Bedrock—granite, uneven, and traversed by hard bars. Tinstone, partly water-worn, black, ruby, resin, and grey. coloured. No black sand associated. The cleaned tin ore is high grade. About 5 tons obtained from about $1\frac{1}{4}$ acres in lower portion of workings. Sluicing operations frequently hampered by water scarcity. Claim worked by F. Heather and E. Holten.

About 10 chains upstream about $1\frac{1}{2}$ acres were sluiced for $6\frac{1}{2}$ tons of dressed tin by F. Heather. Average depth of ground, 5 feet ; channel narrow ; but coarse angular tin extends for about a chain from the north bank. A long head-race cut for sluicing purposes.

Home Creek.—A tributary of the Murray River, traversing Parishes Dora Dora and Vautier, County Goulburn ; 16 miles south-east of Germanton (M.Ls 8. 10, Vautier ; M.L. 1, Dora Dora).

An extensive alluvial flat has been formed along the lower portion of this stream, from some distance above the Albury-Jingellic Road, to the Murray River. Several shafts and numerous bores are reported to have been sunk by an Albury syndicate, revealing an overburden up to 25 feet in depth, consisting chiefly of granite sand with some clay. Bedrock, soft granite.

Considerable difficulty is reported to have been experienced in sinking owing to the loose nature of overburden, and quantity of water encountered ; steam power, and close timbering, were necessary.

The tin prospects are reported to have been favourable (a little gold being also present). The reason for discontinuance was attributed to failure of the Basin Creek dredging operations.

Tin is also reported in McClure's Swamp, a tributary at the head of the creek in Portion 64, Parish Dora Dora.

Honeysuckle Creek.—A small stream joining the Murray River, in Parish Dora Dora, County Goulburn, 18 miles south-east of Germanton.

A small amount of stream tin has been found along this stream.

Maracket Tin Mine.—Cockatoo Creek, $17\frac{1}{2}$ miles south-east of Germanton, Parish Talmalmo, County Goulburn.

Operations by the Maracket Tin Mining Company commenced in May, 1906, and ceased about the end of the year. A tail-race was cut for about 300 yards through a hard granite bar ; and a head-race cut from a dam 1 mile up stream. No tin appears to have been won, the capital being expended on developmental work. The channel is very narrow and bar-bound in several places ; unsuitable for dredging. The overburden consists of 10 to 20 feet of granite sand and clay. The patches of alluvial are isolated by the granite bars. Tin values are understood to be too low for ordinary ground sluicing.

Mountain Creek.—A left bank tributary of Billabong Creek, Parish Moomargama, County Goulburn, 6 miles south-south west of Germanton.

A little alluvial tin and gold have been obtained along the stream in places, but not in payable proportion.

Mount Jergyle Prospecting and Development Company, operating at the junction of Mount Pleasant and Lock Up Creeks, Parish Jergyle, County Goulburn, 8½ miles south-east of Germanton.

An extensive alluvial flat gradually narrowing up-stream. The depth proved at the junction of the streams by boring and shaft sinking, was about 35 feet. A section showing from the surface :—

4 feet granite sand—no tin.
14 feet ,, ,, (a few grains per dish).
2 feet cemented sand and clay.
7 feet drift sand with a little tin.
Up to 8 feet stony wash with tin—the latter mostly on the bedrock,
Soft granite bedrock.

The deepest ground occurs in Lock Up Flat. The wash consists mainly of partly water-worn granite fragments, with a little quartz.

On the north side of the flat extensive beds of cemented granite sand occur close to the surface. The head of the flat is semi-circular, and nearly surrounded by granite hills with some slate and greisen, traversed by numerous small quartz leaders, many of which are slightly tin-bearing.

Rows of bores and shafts have been put down by the Company, with reported satisfactory results, though active operations have not followed. Water could be cheaply conserved if sufficient values exist in the alluvials.

Tumbarumba Mining Division.

Musgrave Tin Mine.—M.L. 1, Parish Currajong, County Goulburn, within Reserve No. 2652. Mount Gifford, Lankey's Creek, about 25 miles easterly from Germanton.

Tin ore is reported to have been found by Musgrave, Senior, early in the sixties. A little stream tin has from time to time been won from Lankey's Creek ; where the drift has been most recently worked by E. T. Holton, by aid of the creek water, and the deeper ground by storm-water at intervals.

The alluvial has a depth of 19 feet at deepest, and contains large boulders (which require shooting for removal) and much rock-rubble. The drift occurs on the points above the present creek bed which is mostly rock bound.

Several tin lodes have been discovered on Mount Gifford, to the east and north-east of M.L. 1, usually containing coarse crystals of cassiterite in granite joints.

In one instance, a lode of rich tinstone, about 1 foot wide, has been opened to a depth of 10 feet, when it passed into solid mispickel. It strikes north 30° east, and dips slightly to north 60° west. In another lode, at the junction of sedimentary rock—about a mile north-easterly—on the opposite fall of Mount Gifford, rich tin ore occurs in schorl.

The lode in M.L. 1, consists of eurite with irregular quartz veins at the junction of muscovite granite, tinstone in coarse crystals showing freely along the outcrop. At a depth of 25 feet the lode becomes arsenical, with wolfram on the hanging wall, and a little copper pyrites. Its thickness ranges from 4 to 5 feet (of eurite and quartz) ; the tin and wolfram appear to make in the quartz, though fine tin occurs also in the eurite.

A large average sample of the lodestuff left in No. 1 shaft yielded :—

3993 { Tin, none detected.
Copper, 0·92 per cent.
Tungstic acid, 0·5 per cent.
Silica, 85·5 per cent.
Gold, a trace
Silver, 2 oz. 5 dwt. 17 grs. per ton
Small percentages of zinc, and arsenic also present.

An average sample from No. 3 shaft yielded —

3994 { Tin, 0·01 per cent.
Copper, 0·20 per cent.
Silica, 91·49 ,,
Tungstic acid, less than 0·25 per cent.
Gold, a trace.
Silver 13 dwt. 1 gr.

Aid granted to sink 85 feet. (See also p. 268.)

Purtell's Gully.—About ¼ mile south of Currajong Tin Mine, 3 miles east of Germanton, Parish Germanton, County Goulburn.

Opened by F. Purtell about 1880. More recently by F. Heather, senior, who obtained 15 cwt. of medium to coarse tin.

The channel is very narrow, and the wash is usually overlaid by a thick bed of hard cement. Water scarce for sluicing purposes.

Spring Creek.—Heading on south side of Mount Pleasant, and flowing in a northerly direction into Yarra Yarra or Billabong Creek, Parish Narra Narra Wa, County Goulburn, 12 miles south-south-east of Germanton.

The stream heads in granite, but intersects schist, quartzite, and conglomerate for some distance downstream. The patches of alluvial are separated by hard and wide bars of sedimentary rock crossing the creek at intervals. The upper portion is only suitable for sluicing, the intermediate small flats for fossickers, and a considerable area downstream for dredging, provided tin values are payable.

Boring over a considerable length indicates the presence of tin in the terraces as well as in the main channel. The former average 30 feet in depth and are fairly extensive, especially on the right bank.

The wash consists mainly of coarse fragments of slate, granite, and porphyry. The tin is partly water-worn, and of high grade.

Tin has also been found in the following tributaries of Billabong Creek :—Wantagong, Stony, Native Dog, and Serpentine Creeks.

Burra Sluicing Claim, about 5 miles south east of Tumberumba, G.Ls. 10–13, Parish Burra, County Selwyn. The presence of tin ore in the Tumberumba Goldfield was noted as early as 1855 by the Rev. W. B. Clarke, who , in a sample received from that locality, found "amongst gems and other rejectamenta of the cradle, some small particles of oxide of tin."* It is extremely probable that the sample came from Burra Creek, for the only other known occurence of cassiterite in the local gold drifts is the very recent discovery in G.Ls. 130, 131, Laurel Hill, Bago, Parish King, County Selwyn.

Tin ore was first officially notified at Burra Creek in 1875, when the Warden reported that the Manager of Burra Sluicing Claim stated :

> "That from about an acre of the creek bed he obtained over 200 ozs. of gold, and about a ton of grey tin ore."†

* Southern Goldfields, 1860, p. 109. † Mines and Mineral Statistics, 1875, p. 25.

From local inquiries kindly made by Mr. J. Saint-Smith, it was estimated by the late Mr. Stanley Ramsay, that 66 acres sluiced at Burra Creek Claim up to about 1902, yielded 2½ tons to the acre, or a total of 165 tons. Subsequent operations have produced an additional 25 tons: workings above the claim, perhaps 50 tons, and those below, 10 tons. The total output being approximately estimated at 250 tons, obtained as a by-product in gold sluicing. Of itself the tin ore would be entirely unworkable, being in very limited quantity in the wash. As it occurs lightly distributed along the whole course of the stream, it is probable that its original source lies high up in the watershed, though no lodes have yet been located.

The Burra Claim is worked by hydraulic sluicing, using a 2 in. nozzle, with a pressure of 140 feet, obtained by means of a race down Burra Creek, 6 miles in length.

A section of the ground in G.L. 12 has been furnished by E. C. Saint-Smith :—

3 to 4 feet chocolate-coloured soil, fairly easily removed by water.
4 feet blue clay, rather stiff.
9 feet coarse drift, with small waterworn quartz pebbles.
2 to 3 feet coarse stony wash.
Soft granite bedrock, very uneven.

Horse Creek, Parish Jingellic East, County Selwyn. Leases for tin mining were taken up in this locality as early as 1872, M.Ls. 1–4 of 25 acres each being measured in that year on the application of J. Hayes. In 1873, M.Ls. 5 to 9 of 20 acres each were surveyed for Messrs M'Rae, Elvy, and Jones, the latter being on Gum Flat and Little Horse Creek.

E. C. Saint-Smith examined the locality in September, 1910, and ascertained that several small patches of tin wash had been worked along Horse Creek in the early days of mining, a number of large nuggets of greyish tin oxide being unearthed.

On a spur on the left bank of the creek, about half a mile above its junction with the Murray River, several quartz veins striking E. and W., in granite, intruding slate, schist, and quartzite were opened by a considerable amount of sinking and driving, and two small stamper batteries were erected to treat the ore obtained.

About ten principal lodes were opened, mostly in the sedimentary rocks, the most extensive development being on a quartz lode averaging about 6 inches in width, on the south fall of the spur. Two shafts, each 50 feet deep, and a long deep cut being sunk on the line. The tinstone occurs in shoots of very limited extent. Several quartz leaders, carrying seams of tinstone, have been followed for a few feet at right angles, branching from the main lodes.

Jingellic Tin Lodes, Parish Jingellic, County Goulburn. Apparently the first leases in the locality were taken up in 1873, for in that year Messrs. Day, Wellington, and Semmes applied for 160 acres on Swamp Creek, Jingellic Run, under Section 58 of the Crown Lands Occupation Act of 1861, covering Semmes No. 1 lode.

M.L. 29 was surveyed in June, 1873 for E. Vickery. Evidently work started shortly after survey, for the first official reference obtainable (in 1876) affords evidence of considerable development having taken place The Warden reported :—

> "I have learned from the manager of the Jingellic Tin-mining Company, that the following work has been done :—One tunnel driven 162 feet, and another 400 feet. One shaft sunk 62 feet, another 50 feet.

There are about 300 tons of stone at grass, and that operations with machinery will commence on the 1 February next, when twenty men will be employed; at present there are only seven. The machinery consists of crushing plant complete—engine, boiler, and water wheel."*

In 1878, the Manager reported to the Warden:—

"During the past year I have paid, in wages, £1,958 12s. 2d.; mining material, £1,140 10s. 4d.; making, together, £3,099 2s. 6d.

"Our machinery is all erected, and consists of a 25 h.p. engine, with 24 feet by 6 feet boiler; and 12 head of stamps with 24 feet riddle. We have constructed a water-race from Swamp Creek, 2 miles and 30 chains, to our mill; but the season being so very dry here, we have yet no water to crush with, and I have been obliged to discharge twenty men until the rain sets in.

"Our tramroads finished and in course of construction consist of 4,627 feet of single lines of horse roads, and 2,640 feet of double line self-acting mountain road, 3-feet gauge, and rising 500 feet in its length, and carrying 3-ton trucks.

"The work done on the four lodes now opened is: Length of tunnels driven 510 feet; drain 440 feet; and the sinking done in the different shafts amounts to 157 feet; and the gross amount of all stone raised at the different lodes is about 680 tons, and the total expenditure to date is £6,000.†

No report of progress appeared in 1879, but in 1880 it is recorded that:—

"The Jingellic Tin Mines, under the auspices of a Melbourne Company, made something of a start during the year. Some mineral licenses were taken out, and fresh ground and water privileges secured. The company have selected a considerable area, preferring this mode of holding the land. The actual work done as yet does not, I am informed, amount to very much. While the water lasted, some tons of stream tin were extracted; at present there is not sufficient water for washing, nor even enough to supply the machine, and what work is being done is chiefly confined to sinking and taking out the tin-bearing quartz, a considerable quantity of which is now at surface. The prospects are promising."‡

In 1881, the mine was visited by E. F. Pittman, who reported:—

"The tin reefs are situated principally in the high granite range extending along the north bank of the Murray at the head of Swamp Creek. A flat about 1 mile long extends from the bank of the Murray up to the foot of the range, and here the Swamp Creek branches, the western branch being known as Little Swamp Creek. The Jingellic Tin-mining Company hold about 400 acres of land (a considerable area being freehold), and have also the right to mine on the flat.

"In the ranges above the flat, I inspected eight well-defined quartz lodes bearing in a more or less easterly direction, and all carrying tin in greater or less quantity.

"No. 1, the most northerly on the range, is situated at an elevation of about 900 feet above the Murray. It bears east and west and is almost vertical, having a slight dip to the north. A tunnel has been put in along the course of the lode for a distance of 160 feet, and a winze 30 feet deep. The quartz in this lode contains in places a large amount of tourmaline (schorl) with some wolfram, and a fair sprinkling of tin oxide. The lode varies in width from 10 inches to 2 feet, and carries a casing rich in brown tin.

* Ann. Rept. Dept. Mines for 1876, p. 67. † *Op. cit.*, 1877, pp. 99, 100. ‡ *Op. cit.*, 1880, p. 133.

"The extreme north lode which has been discovered up to date is known "as No. 6," and is about 1,000 feet north of No. 1, at an elevation of 1,000 to 1,100 feet above the level of the Murray. This lode also bears east and west, and so far as it has been tested, is found to vary from 4 feet 6 inches to 6 feet in width. The lode has been traced for about 1 mile in an easterly direction. It contains fine tin in streaks through the quartz, and only traces of wolfram and tourmaline, while the casing carries coarse tin. A shaft has been sunk 70 feet* on the lode (which measured 4 feet 6 inches at that depth), and a tunnel put in 300 feet through the granite to strike the lode at right angles. I was informed that 10 tons of stone had been crushed from this lode, and had yielded 16 cwt. of tin oxide, and, as far as I could ascertain, this is all the prospecting that has been done on the field. About 20 feet from this lode, and running parallel with it, is a smaller one varying from 4 inches to 2 feet in width, and similar in character, carrying streaky tin in the body of the stone, and coarse tin in the casing.

"Between No. 1 and No. 6, four well-defined lodes occur, the outcrops having been discovered to the westward of the two just mentioned, and at a higher elevation on the range.

"The nearest to No. 6 is a 2 feet lode bearing north-west and south-east, and, therefore, junctioning with the northern lode.

"No. 5 will also junction with No. 6 on the south side. It bears north-east and south-west, and has been opened at an elevation of between 1,200 and 1,300 feet above the Murray. The lode here is 5 feet wide, but carries a granite horse 1 foot wide. The south side of this lode carries fair tin.

"No. 4 lode bears 10° north of east, and is 4 feet wide on the surface and 6 feet 6 inches at a depth of 10 feet. It contains much arsenical pyrites, some wolfram and tourmaline, and a good percentage of tin. This lode has been proved for a distance of 8 chains.

"The next lode to the south (No. 3), is also a wide one, being 4 feet on the surface. It contains streaky tin, and resembles No. 6 in character.

"Near the foot of the mountain on Little Swamp Creek is a lode known as No, 7. It averages from 2 feet 6 inches to 4 feet wide, and bears north 52° west. A tunnel put in from the foot of the hill strikes a shaft at a depth of 76 feet. A drive was put in to the east from this shaft, but the tin was here found to run out. According to the careful measurements made by Mr. Blythman (Manager of the Company), an adit from here into the range would require to be 2,000 feet long in order to intersect all the lodes abovementioned.

"Another east and west lode occurs about a chain north of this. It is about 2 feet 6 inches in width, and was formerly thought to be identical with No. 7. This lode contains coarse tin, but appears to be patchy. From this point an inclined tramway has been constructed up the mountain for 23 chains. When completed it will lead to the tunnel mouth on No. 1 lode and will then be about 45 chains in length.

"No. 8 lode, about 2 or 3 chains still further south, is from 10 to 18 inches wide and bears east and west. A shaft has been sunk for 70 feet, and the men are now at work in the 18 feet level taking out a parcel of 30 tons for a trial crushing.

* Reported to have been continued to 220 feet, where the thickness was 6 inches.—J.E.C.

'The Company owns a 25-h.p. engine, battery of twelve stamps, two fixed circular buddles of 22 and 24 feet diameter respectively, roasting furnace, &c.

"Judging from the surface indications, I am of opinion that these lodes are likely to prove remunerative, and if such be the case, they are of such extent that there is no doubt this mine will be a very valuable property; but so far next to nothing has been done in the way of prospecting, and as far as I could learn no more than 10 tons of stone have ever been tried with a view of testing its percentage of tin. Mr. Blythman informs me that it is now his intention to crush and treat about 30 or 40 tons from each of the more important reefs, so as to get a fair idea of their value.

"One of the first points which strikes a visitor is the evidence of the reckless manner in which money has been spent on the property. The crushing machinery has been erected on the Little Swamp Creek, where there is no water. A race 3 miles long has then been cut from the head of Swamp Creek to supply the engine and battery with water, but owing to the rotten nature of the granite it is found that the water leaks out and the race is next to useless. Now, by going about half a mile south a site could have been obtained on the Swamp Creek with sufficient water to work thirty or forty head of stamps, or better still, by placing the machinery on the Murray water would be available for an unlimited number; and it is needless to point out that if these reefs proved to contain sufficient tin oxide to pay for treatment, they are of such size and so numerous that the company could easily keep a hundred or more head of stamps at work on the stone.

"The flat (which has been before alluded to) between the Murray River and the range in which the lodes occur, will probably contain payable alluvial deposits of tin oxide, and there appears to be sufficient fall to work it by means of a tail race from the river." *

In 1882 a fresh impetus was given to mining at Jingellic under new management. It was reported that a new company had been formed under the auspices of the proprietors, Messrs. Hastings, Cunningham, & Co., of Melbourne. The spurt, however, did not last long, in the following year the Mining Registrar reported that the mine had not realised expectations.

"The Jingellic Estate Company suspended work after a very considerable outlay. Another company, whose ground is adjoining, put up machinery for crushing, and, with very commendable energy, kept trying for a payable tin lode, having found a few good patches near the surface, and indications of the reef going to a depth. On the old Jingellic Mine, lower down the River Murray, I am told some alterations have been in progress, with a view of further developing its resources, and it is said to be looking better."†

In 1884 the tin mines were reported closed, with little prospect of re-opening.

No further reference occurs until 1888, when Butler and party took up a lease for lode tin-mining at Jingellic; and in 1889 the same party raised a small quantity of stream tin in the same locality.

After a long lapse a little mining was done in 1905, but was soon abandoned.

* Ann. Rept. Dept. Mines for 1881, pp. 143-144. † *Op. cit.*, 1883, p. 85.

It is locally reported that a parcel of about 9 tons of tin concentrates obtained during operations at the Jingellic reef failed to obtain a sale, and was eventually lost in Melbourne. Very probably its contamination with wolfram interfered with the sale at that date.

E. C. Saint-Smith visited the lodes in September, 1910, and states that fourteen parallel lodes were opened during operations, varying in width from 1 to 6 feet. Numerous small lodes occur alongside the main lines, in some cases branching from them. The lode material is bluish quartz, in which the tin occurs in very thin seams, usually on the walls. Large crystals of cassiterite occasionally occur, the finest being found loose on the surface The tinstone occurs in the lodes in the form of shoots; wolfram is an associate. The proportion of tin to wolfram is estimated as 3 to 1.

The total output from these lodes is estimated approximately at 10 tons. Fossickers occasionally work amongst the outcrops, but the winnings are unimportant.

Lankey's Creek.—A western tributary of Coppabella Creek, ; Parishes Coppabella and Currajong, County Goulburn; 20 miles east-south-east of Germanton.

Close to the Lankey's Creek Post Office a small amount of alluvial has been worked mainly by E. Holton and F. Heather, about 4 tons of dressed tin ore being obtained. Heather and Sons began operations in 1899. The stream traverses granite, schist, and slate, the latter forming the bedrock at the workings. Large granite boulders occur in the wash, which is very stony. The bottom wash is cemented and hard. Tin occurs throughout, but is usually richest near the boulders. The width of the channel is about 2 chains, and the depth from 3 to 18 feet. The tinstone is black, but occasional patches of grey tin ore occur. The ground is reported to average about 1 lb. per yard. Odd colours of gold occur as an associate. The bedrock is uneven, and traversed by hard slate bars. The tinstone is medium to fine-grained, and partly waterworn.

About 22 chains above Holton's claim a small rich patch of wash was found close to the creek, rich patches at a higher level were also discovered.

About a mile up-stream an attempt was made to work another deposit, but the presence of wolfram is reported to have militated against success—the grade of the tin not being above 55 per cent.

Numerous tongues of granite hereabouts intrude the slates which are rendered schistose in consequence. Loose fragments of tin oxide are seen on the road alongside Lankey's Creek after rainfall.

Laurel Hill, Bago.—G.Ls. 130–131, Parish King, County Selwyn.

In May, 1909, Mr. Warden Fincham submitted a sample of black sand from G. Rutherford's gold leases at Laurel Hill, worked by tunnel 1,800 feet in length under basalt. It is reported that where the black sand is most plentiful in the wash the best gold returns are obtained. An assay of the sand revealed 2·07 per cent. of metallic tin.

Musgrave Tin Lode.—M.L. 1, Parish Currajong, County Goulburn, on the western slope of Mt. Gifford, Lankey's Creek.

Stream tin has been worked, to a small extent, for a number of years in Lankey's Creek, which runs at the foot of Mt. Gifford, below the above lode. Though loose specimens of lode tin had been known for many years in the vicinity of its outcrop, no serious attempt was made to locate their source.

Several lodes occur on Mt. Gifford, in which coarse crystals of cassiterite occur. The best defined has been opened by the Musgrave Tin Lode Company (No-Liability) close to the junction of granite and altered sedimentary rocks. It occurs in the granite and strikes N. 11° E. to the slate. The

underlay is slight to eastward. The lodestuff is eurite, with short irregular veins of quartz. Coarse crystallized tinstone occurs in the outcrop, but very little was visible at the bottom of the three shafts, which at the date of inspection, December, 1908, were from 28 to 33 feet deep. At the lower levels mispickel becomes prominent, associated with a little zincblende, copper pyrites, and wolfram. Assays of samples of this ore from the two principal shafts returned very disappointing results—only a trace of tin being detected. The width of the lode varied from 3 to 5 feet.

Aid from the Prospecting Vote was granted to further test the lode by deepening the most northern shaft, and driving at the bottom to the slate junction.

At 50 feet the lode was reported to be 4 feet wide, and showing tin ore, and similar prospects at 60 feet. The granite was hard, requiring explosives.

Suspension of labour conditions was subsequently obtained.

Examined by E. C. Saint-Smith in September, 1910. Work had not been resumed. The copper pyrites is reported to have given out at about 40 feet. Coarse, crystallised, grey and reddish-brown tin oxide occurred in thin seams. Much tourmaline present. Lode opened in five places, at intervals of 1 chain. Scheelite occurred at 44 feet in one shaft. The uncommon association of wolfram and scheelite in the lode is noteworthy. About 18 cwt. of tinstone, assaying 21 per cent. was despatched to a Melbourne smelting company.

Several small parallel quartz veins have been found near the main lode. The acid granite in which they occur gradually passing by imperceptible stages into quartz.

In an open cut two thin seams of tourmaline occupy the position of the tinstone in another portion of the same lode.

About half-a-mile north-east of these workings tin and tourmaline occur in association; about the same distance still further north easterly, coarsely crystalline tinstone is stated to occur.

See also p. 262.

Swamp Creek, a tributary of the Murray River, Parish Jingellic, County Goulburn, 22 miles east-south-east of Germanton.

Tin is reported to have been discovered here in 1871, near the head of the stream, close to the Jingellic tin lodes, which were covered by leases in 1873. Operations were hampered by water scarcity for sluicing purposes. The tin ore obtained was mostly fine-grained, though several coarse nuggets were found.

In 1910 the creek was being worked by Messrs. Crawford and Kohn in M.L. 21, about three-quarters of a mile below the lodes. The average depth is here about 6 ft., consisting of bluish clay and granite sand, resting on coarse stony wash. The wash averages about 1½ lb. per barrow load, according to the miners, the channel being about 20 feet in width. It consists of granite and quartz pebbles, with frequent fragments of quartz, carrying tinstone. Tin extends into the banks.

Below M.L. 21, the channel becomes precipitous, but a little tin was obtained in the flat at the junction with the river, and a little also along Little Swamp Creek, a western tributary of the main creek.

Tumbarumba, 15 miles north-east of. A sample of lode tin submitted for assay by H. Pether, Talbingo, from the above locality, yielded 57·70 per cent. of metallic tin.

Wagga Wagga Mining Division.

Bald Hill Gully, between Carter's Hill and Bald Hill, a right-hand tributary of Bourke's Creek, 1½ miles north-west of Pulletop Homestead; Parish Burrandana, County Mitchell.

This small gully was worked for tin and wolfram many years ago. Average depth of sinking about 12 feet, through granite sand and bluish clay. The tinstone and wolfram particles were unworn, and doubtless derived from the numerous small lodes in the vicinity. A small quantity of concentrates obtained.

Pulletop and Clifton Stations.—Parishes Pulletop, Burrandana, and Westby, County Mitchell.

The earliest recorded discovery of tin ore in this locality dates back to 1872, when mining leases were taken up on Clifton station, and surveyed early in 1873.

In 1874 it is recorded that the Pulletop Tin Mining Company raised 1,200 lb. of tin-ore, valued at £40.*

In 1894 the Writer visited the site, as attention was again being directed to the mixed tinstone and wolfram deposits of the district, owing to a reported discovery of lode tin on Clifton, about 8 miles from Pulletop homestead. A good deal of prospecting was done in the early days of discovery, and at rare intervals subsequently, both for lode and alluvial, without profitable results, excepting, perhaps, to a few fossickers. Impressions formed after inspecting all the then known stanniferous outcrops and alluvial deposits were that conditions were unfavourable to successful mining enterprise, an opinion which subsequent development and examination tends to confirm.

The difficulty of finding a remunerative market for the mixed concentrates of tin and wolfram in 1894 was acute. An average sample, selected by the Writer from the proceeds of a small trial with a box-head sluice, containing by assay 27·72 per cent. of metallic tin, and 28·82 per cent. of tungstic acid, was found, after considerable inquiry abroad by Harrold Brothers, to have a prospective value of £15 per ton, less £3 per ton for treatment.

The impossibility of procuring a sufficiently large average sample at the time—about half a ton—for experimental purposes prevented any really definite figures of value being quoted.

At this date a partial roasting and leaching process for removal of wolfram was in vogue to a slight extent. Magnetic separation is now successfully applied to these minerals of equal specific gravities. The occurrence of wolfram and tinstone in quartz veins on Clifton and Pulletop is extremely patchy, and very leanly distributed, nothing approaching payable proportions yet being discovered. The alluvials along Pulletop Creek, consequently are also patchy and limited.

In Portion 13, Parish Burrandana, Inspector Hooke examined several veins carrying tinstone and wolfram, opened to 16 feet by shaft. Aid was granted from the prospecting vote to continue to 50 feet, but apparently the attempt was abandoned without taking advantage of the assistance offered.

In 1899 attention was directed to tin and wolfram in a lode outcropping in the bed and banks of Bourke's Creek, near Pulletop. The alluvial was reported to prospect 1 oz. to the dish, but apparently nothing followed.

In 1908 a small quantity of tin was obtained from Pulletop, and an area applied for for dredging purposes.

* Mines and Mineral Statistics, 1875, p. 62.

In 1909 a sluicing plant was to be erected on the area held by J. Turner, at Bourke's Creek. Some delay was occasioned by difficulty of procuring carriage of machinery to site.*

Victory Tin Mines (Dudley Syndicate).—M.Ls. 23, 25, &c., Parish Westby, County Mitchell, near right bank of Bourke's Creek, 16 miles N.N.E. of Germanton.

E. C. Saint-Smith examined this locality in September, 1910, and reports several thin quartz veins occurring in a biotite granite. Average strike about N. 80° E., with slight south-easterly underlay. The most eastern workings, on Clifton Hill, consist of an open trench about 150 feet in length by 10 feet in depth in hard granite. The shoot of tin and wolfram practically cut out vertically in the trench, but continues on the strike easterly.

The widest part of the lode is 4 inches, but splits into strings. It consists of greisen at this point, and much coarse white mica occurs in the zone of alteration adjoining the lode. Walls undefined.

Only a small quantity of mixed tin and wolfram has been obtained from this, the first working by the present Company, since commencing operations in April, 1910.

About 10 chains west of this lode a similar one was opened for a length of 150 feet and an average depth of 10 feet. The lode material is quartz, with mispickel, and a little tinstone and wolfram in about equal proportions. It has so far proved unremunerative. Several thin veins branch from it at varying angles, whilst the main lode itself repeatedly splits into numerous veinlets, and then reunites.

One chain east of this lode a large parallel lode occurs, which was opened several years ago, but proved barren.

About 15 chains west a small micaceous lode was opened for about 240 feet and a depth of 8 feet. It consists of quartz, with tinstone and wolfram, and has a maximum thickness of 8 inches. So far prospecting results have been discouraging.

Numerous other small veins have been opened in close proximity, with no better success. The granite assumes a more decidedly micaceous character to the westward, and much crystallized coarse black tourmaline is present.

On the west end of the present workings a new lode has been opened, which, so far, has given more satisfactory prospects, wolfram being practically absent. The proving, however, is as yet very superficial, being confined to a shallow trench.

The lode material is decomposed micaceous granite, with disseminated fine-grained tinstone. A large barren quartz vein occurs on one wall.

A little alluvial has been worked in an adjacent gully, but water is only available in wet weather.

About 8 chains north-west of the last-mentioned lode a similar one was opened many years ago by a trench 120 feet long and 15 feet deep. Several rich patches occurred, but operations were generally unremunerative.

The lode splits into veinlets, and reunites at intervals, as in the case already referred to.

The veins gradually taper out to a thread, and then commence again a few inches to right or left of original strike, and continue parallel to it. They appear to occupy shrinkage cracks in the granite.

Several barren quartz reefs occur in the area, usually with iron and arsenical pyrites.

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* Ann. Rept. Dept. Mines, 1909, p. 53.

The Victory Company erected a 4-head stamper battery, with Wilfley table, driven by an 8 horse power engine. About 2 tons of mixed tin and wolfram obtained assayed 25 per cent. metallic tin. Much iron was present in the concentrate.

(*g*)—Central District.

Cobar and Lachlan Mining Districts.—Progress of Development.

In 1854 the Rev. W. B. Clarke found tin ore in the Upper Bogan River detritus.*

About 1874 a sample of stream tin ore was received in the Department of Mines, purporting to come from Burra Burra Station, in the Lachlan Mining District.

In 1880, Lamont Young, Geological Surveyor, accompanied by the Writer, made a reconnaissance of the above districts; his report thereon contains the first official reference to the occurrence of tin in this portion of the State :—

> "From Burra Burra I visited the locality, as shown on my map, where tin ore was said to have been found six years ago [on Burra Burra Station.—J.E.C.], but my search was unsuccessful; a considerable quantity of quartz débris and brown iron ore were the only minerals found in the small channels. I consider, however, that tin ore does very likely occur in this part of the country, since it is near the junction of granite and slate formations that that mineral is found in the great tin-mining country of Cornwall."†

The search mentioned was brief and purely superficial; no work had been done; and the rare channels of these districts, being always filled with sand, afforded no sections. The site, moreover, had been but approximately located.

In 1882, Mr. Harrie Wood recorded copper, gold, and tin between the rivers mentioned.‡ In the same year Professor A. Liversidge recorded tin in granite near Eremeran§; evidently the first reference to lode tin at the present Mount Tallabong mines.

In 1893 an alluvial lead containing tin ore was discovered at Burra Burra,‖ the sinking varying up to 20 feet. The deposit proved neither rich nor extensive, and was soon abandoned. No lodes were discovered. Several samples of the clean ore assayed in the Departmental Laboratory averaged 72·9 per cent. of metallic tin.

In 1894 several samples were received, variously described as coming from near Mount Hope; Tallabong Mountain; 60 miles south of Nymagee; and Urambie Run. In each case the tinstone was associated with quartz, one sample with wolfram and arseniate of iron. The assayed values in metallic tin ranged from 4·12 to 41·6 per cent., averaging 23·83.¶ The lodes from which these samples were taken were discovered by C. Eason and A. McDonald.

In 1895, J. B. Jaquet, mentioned that small quantities of drift, "yielding a payable quantity of platinum associated with gold and tin (cassiterite)," had been worked near the village of Burra Burra.**

In 1897, 7 tons of Urambie lodestuff were treated at the Government Metallurgical Works, Clyde, for Hogan and Party, for a return of 4·83 per cent. metallic tin by assay.

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* Cat. Nat. and Indust. Products N. S. Wales, Paris Exhibition. 1854, p. 61. † Ann. Rept. Dept. o Mines for 1880, p. 259. ‡ Min. Prod. N. S. Wales, 1882, p. 26. § *Op. cit.*, p. 102. ‖ E. F. Pittman, Min. Resources N. S. Wales, 1901, p. 147. ¶ Ann. Rept. Dept. Mines for 1894, p. 52. ** *Op. cit.* 1895, p. 183.

The results of the process of concentration are revealed in the following return, dated December 16th, 1897 :—

Crude ore—Assayed contents :—
Tin, 4·83 per cent.
Bismuth, 0·25 ,,
Gold, a trace
Silver, 3 oz. 17 dwt. 1 gr. } per ton.

Vanner Concentrates, 1sts—
Tin, 50·76 per cent.
Bismuth, 0·12 ,,
Gold, 2 dwt. 7 gr. per ton
Silver, 4 oz. 17 dwt. 15 gr. ,,
} Proportion to bulk, 1·23 per cent.

Vanner Concentrates, 2nds—
Tin, 27·46 per cent. Proportion to bulk, 4·17 per cent.

Tailings—Tin, 3·49 per cent.

In 1900, Inspector Godfrey examined the Urambie lodes in connection with applications for aid from the Prospecting Vote, and reported three main lodes with quartz and tinstone in slate and sandstone, near granite. Strike N. 30° W.; dip flat to eastward.

These lines were then known as Cornish's, Lean's, and Hogan's, about 200 to 300 yards apart, with smaller veins between. Aid was granted for several shafts, and for cross-cutting; also for testing the alluvial.

In 1907, several miners appeared to be making a living by handpicking the Urambie ore and despatching it to Sydney.

In 1908, only a few cwt. of tinstone were obtained.

In 1909, ore to the value of £103 was won. Inspector Smith reported several small veins being proved, but very little work done for some time.

The alluvial of this locality was held under the name of the Kingston Tin Mine in 1909; samples of the dressed ore yielding 64·2 and 73·2 per cent. of metallic tin.

Altogether, ten leases, aggregating 369 acres, were surveyed at Urambie.

In 1910, the majority of these were held by the Mount Tallabong Tin Mines (Limited), which has erected a battery and concentrating plant.

In 1903, and again in 1908, samples of tinstone in quartz were received from O'Keefe's lodes, near Vermont Hill, on the road from Melrose to Bobodah, where narrow tin veins are known to occur about 4 miles from J. Faulks' residence at Vermont Hill.

Euabalong Division.

Mount Tallabong Tin Mines, Limited, M.Ls. 1–7, Parish Urambie East, County Blaxland, about 45 miles north-west of Condobolin. Area, 240 acres.

The following report was furnished by M. Morrison, Senior Field Assistant, after an examination in 1910 :—

"The country rock consists of slates and sandstones. Granite occurs about 1 mile west. The tinstone occurs in quartz veins, apparently six in number, having a general strike of north 25° west. They are very irregular in size, varying from 1 to 10 feet in width.

"Tinstone is known to occur, within a narrow belt, for a distance of over half a mile in a north and south direction; but the length of any definite lode has not been proved for any appreciable distance.

"Three shafts have been sunk in different outcrops, in each case the lode is reported to have cut out as it was followed down."

The deepest working is 120 feet; 75 feet in shaft, and 45 feet in winze, following a vein of a reported average width of 9 inches, which was also driven on for 45 feet.

The most southerly shaft has been carried down 103 feet, on a lode 3 feet wide at surface, but reported to have pinched to 3 inches at bottom.

Sufficient work, however, has not yet been done to determine the exact nature of ore occurrences.

The present company (Mount Tallabong Tin Mines, Limited) has a capital of £3,000, for testing the lode by open cut, treating the material as a stock-work.

A 13-head stamper battery has been erected, with a concentrating plant consisting of two Wilfley and one Krupp tables.

Mr. J. H. Reid, under date 9th November, 1910, informed the Writer that the crushing plant was ready; and that tanks had been excavated since May, but owing to absence of rainfall sufficient water had not been conserved to justify starting crushing. About 1,000 tons of lodestuff were mined ready, and a few miners were employed adding to the stock.*

The following particulars of tin ore despatched from the field were supplied by Mr. A. Crowe, one of the prospectors:—

Tons	cwt.	qr.	lb.	Assay Value.
4	11	0	16	26·0 per cent. metallic.
0	9	3	5	50·2 ,, ,,
0	15	3	3	47·6 ,, ,,
0	3	3	22	28 7 ,, ,,
0	19	0	3	36·0 ,, ,,
0	4	3	11	63·8 ,, ,,
0	12	2	8	51.5 ,, ,,
1	8	3	4	29·0 ,, ,,
2	16	1	20	26·0 ,, ,,
Total..... 12	2	1	7, containing 3 tons 16 cwt. 2 qr. 17 lb. of metallic tin.	

Alluvial.

Mount Tallabony Lead, M.Ls. 11 and 12, Parish Urambie East, County Blaxland. Area 80 acres. Held by Messrs. Miller, Crowe, and party.

M. Morrison described the occurrence as follows:—

"The lead is situated on the eastern side of the tin lodes, trending north-easterly, and reported to have been proved over 100 feet wide.

The overburden varies in thickness from 18 to 28 feet; the wash from 1 to 3 feet. The latter is rather loose, and contains occasional blocks of quartz containing tinstone, though no sign of abrasion is visible. It is estimated to yield about 7 lb. of tinstone to the load.

A number of shafts have been sunk in the lead, mostly in the vicinity of the lodes, but very little tin has, so far, been won from it, the limited water supply available being insufficient to deal with large quantities of wash-dirt. About 7 cwt. of tin concentrates, assaying 63 per cent. of tin, had been despatched by Crowe and others to date of inspection. Other small parcels have been disposed of, of which there is no record.

Stream tin is reported to occur about 5 miles from the present workings.

Burra Burra Lead. Mostly within the surveyed village of Burra Burra, in the north-west corner of Parish Burra, County Kennedy.

Tin ore was discovered in the alluvial at Burra in 1893, doubtless owing to prospecting stimulated by the gold and platinum discoveries at Fifield, about 10 miles south-easterly.

* Crushing and concentration began in February, 1911.

W. H. J. Slee visited the site in May of that year, and subsequently reported :—

"I then proceeded to the tin discoveries in the Parish of Burra Burra, about 10 miles westerly from the gold rush, and found about 200 persons on the ground. About six parties are on payable tin, and the sinking is from 6 to 20 feet in depth."*

Writing at a later date, October 20th, he further reported :—

"The tin-field has been quite deserted by Europeans, and a man named Litchfield is now negotiating with some Chinese to work these tin deposits."†

In 1899, leases for tin-mining were taken up, but practically no work was done.

During 1900 14½ cwt. of tin ore was obtained from the field, from that year on to 1904 small quantities were won by fossickers, the deposits proving very patchy.

During 1905 and 1906 the product had a total estimated value of £1,266. Apparently no work was in progress in 1907.

In 1908 a few fossickers won tin ore to the estimated value of £350.

M. Morrison visited the field in June, 1910, and furnished the following notes :—

"The Burra field was discovered in May, 1893 ; a rush brought several hundred men on the ground, but the majority left within a few days. Operations were carried on for about three months, and then the field was practically abandoned until 1899. Since then fossicking has been carried on at intervals whenever water was available. About 12 tons of tin ore are reported to have been won during the past five years.

"The country is slate and sandstone, with granite about 5 miles distant. The lead runs approximately north and south for about 1 mile. The overburden varies from 4 to 18 feet, the wash from 1 to 1½ feet, and contains a little gold associated with the tinstone. The latter occurs in patches in the wash, averaging 10 to 20 lb. to the load according to report.

"Operations have been retarded by limited water supply."

Buddigower Lodes.—Parish Buddigower, County Bourke, about 12 miles south-west of Wyalong.

E. F. Pittman examined the locality in 1901, and reported that the lodes were discovered by John Smith (a miner engaged for many years in the district), who also discovered stream tin several years before at Narriah, to the north of Yalgogrin, which, however, proved of no extent. The more recent find is thus described :—

"The formation in which the tin deposits of Buddigower occur is granite close to the junction with slate. The granite has intruded the slate, and, as is generally the case, the junction of the two formations follows a very irregular course. Within a distance of a few yards of this junction the outcrop of a quartz lode occupies the summit of a small granite hill, forming part of the water-shed between the Lachlan and Murrumbidgee Rivers. The lode appears to be about 7 or 8 feet wide ; its course is east 5° south, and it dips towards the north at an angle of perhaps 60°. Near the summit of the hill the outcrop of the lode is covered by about a foot or more of granite soil, and in this occur loose

* Ann. Rept. Dept. Mines, 1893, p. 65. † *Op. cit.*, p. 64.

angular boulders, or shode stones, of almost pure greyish-white cassiterite or tinstone. These boulders vary in size, the largest hitherto found being nearly 30 lb. in weight. An assay of one of them showed that it contained at the rate of 73½ per cent. of metallic tin. There is every reason to believe that the boulders have been shed from the quartz lode by the denudation of its upper portion or outcrop. Up to the present no bunches of tinstone at all comparable in size to the loose boulders have been found in the quartz lode, but the latter is seen to contain veins and impregnations of tin-ore, chiefly in connection with arsenical pyrites (mispickel). Very little prospecting has, however, yet been done, the deepest shaft being less than 10 feet; and until the lode has been opened up to a considerably greater depth it would be impossible to form a reliable opinion as to the chances of the deposit proving payable.

"A number of other smaller quartz lodes, which strike in various directions, have already been found to contain tin, and it is possible that some of these may prove to be branches of the main lode. At least five other leases are at present on ore containing a proportion of tin, but in no case has sufficient work been done to prove whether the deposits are of a payable character.

"The prospector's lease is the only one where loose boulders or shode stones have been found."*

The prospectors raised 4 tons of ore during 1901 at from 2 to 8 chains from the main or first find, which they forwarded to the Sydney Smelting Company; 1½ tons yielded 18·7 per cent., and 2½ tons 6·6 per cent. of metallic tin, equal to a total return of 8 cwt. 3 qr. 17 lb.

No record is obtainable of returns of output—if any—during 1902 and 1903.

In 1904 ore was raised to the value of £290. In 1904 aid was granted to sink from 27 feet to 127 feet, following the lode on the underlay; but the prospects were not encouraging. In 1905 the value of ore raised is estimated at £93, and £257 in 1906.

Barmedman Division.

Mandamah.—On Mandamah West Pastoral Holding. about 4 miles north-westerly from Broken Dam, Merool Creek; in Parish Langi-kal-kal, County Bourke, about 23 miles north-westerly from Temora.

The occurrence of tin ore (stream) was reported in 1885, but scarcity of water and capital prevented development. A sample of the concentrates tested yielded 52·3 per cent. of metallic tin.

In July, 1888, a rush ensued to the locality owing to discoveries by Roberts and party. Stream tin was struck at 12 to 15 feet; the wash varying from 1 to 4 feet thick. Ten claims were taken up.

In 1889 the prospectors sold their interests to a syndicate, the latter, after excavating a tank and sinking a number of shafts at an outlay of about £400, were offering the property for sale. During operations about 200 loads were raised, estimated to yield 20 lb. to the load. Prospects not encouraging.

In this year the site was visited by G. A. Stonier, Assist. Geological Surveyor, who stated that three leases, aggregating 180 acres, had been applied for, and described the occurrence of tin in the following terms:—

"The ridge, on which the tin was first found, forms a water-parting, and trends in a north-easterly direction. From it spurs run almost at

* Ann. Rept. Dept. Mines for 1901, p. 158.

right angles, and gently slope to flats on either side, while between them are patches of alluvial. It is in one of these gullies that the best prospects have up to the present been obtained.

"The top of the ridge is 290 feet above Merool Creek, at Broken Dam, which is about 4 miles distant in a south-easterly direction. The formations represented are:—1, Granite; 2, Pliocene-Tertiary; 3, Post-Pliocene. Granite is the only rock known for some distance around the leases, but it cannot occupy any great area, as the occurrence of slate has been noted within 4 miles on either side. Hard bosses show up through the soil in places, but there is an absence of 'tors,' and the rock is so readily decomposed that the crop is frequently much obscured. It consists of quartz, felspar, and mica, both muscovite and biotite. Two distinct kinds occur, and they differ, not in mineral components, but in degree of crystallization, that to the south of the leases containing porphyritic crystals of felspar, white and pinkish-white, up to $1\frac{1}{4}$ inches in length, many of them showing the twinning characteristic of orthoclase. . . . In a tank which is being excavated on Block 15, five small veins have been exposed. The thickest is about 8 inches, and carries thin leaders of fine black crystallized tinstone in the quartz. The others vary from 2 inches to the thickness of a knife-blade, and it is stated that each is stanniferous. They run nearly parallel, bear about W. 20° S., and are almost vertical."

(2.) *Pliocene-Tertiary.*—"This consists of a drift of quartz, angular and sub-angular, but chiefly well rounded. . . . Several shafts have been sunk, but none have been bottomed, the deepest being 16 feet. In each case tin was found, though not in payable quantity. These shafts should certainly be bottomed, in order to prove the channel of this ancient tertiary deposit."

(3.) *Post-Pliocene.*—"The enormous denudation to which the country has been subjected since Pliocene times has resulted in the Pliocene drift being naturally ground-sluiced, and the tin contained therein concentrated in another deposit consisting of the denuded portion of both the Pliocene and the granite."

"The lead has been proved to the western boundary of Portion 17. At this point the alluvial is wide, but the width of the lead has not yet been determined. Owing to recent rains the shafts were full of water, so I was unable to examine any of them. Mr. Roberts informs me that the wash is 5 feet thick, with a good prospect of tin."

"Starting from the western boundary of Portion 17, the alluvial can be followed in an easterly direction to the north-western corner of Portion 15, and here it receives a branch running parallel to the eastern boundary of the portion, while the main body continues into Portion 16." . . . "The prospect work done has been very little, but in several places the presence of wash carrying good tin has been proved. The tin itself is fine, with a few pieces up to $\frac{3}{4}$ inch in length. Most of it is angular and sub-angular, very few rounded pieces being noticeable. The colour varies from honey-yellow—sometimes translucent—to black. The associated minerals are tourmaline, magnetic iron, and a little gold. Wolfram is said to occur, but of this I did not see any specimens."

"The wash is composed of mica, clay, and irregularly-shaped grains of quartz, with larger and water-worn quartz pebbles. The cementing material is chiefly clay and red peroxide of iron. Its thickness varies from 2 to 5 feet, and the sinking from 10 to 15 feet."*

* Ann. Rept. Dept. Mines for 1889, pp. 234, 235.

In 1905 aid was granted to sink and drive at a new find 5 miles west from the above. Two cwt. of stream tin having been obtained from twenty loads. Apparently nothing payable was discovered.

Yalgogrin Division.

Mulyan.—Tin ore was discovered at Mulyan by E. Connolly in June, 1906, in C.L. 6,079, Parish Kikoira, County Dowling, about 18 miles north-westerly from Yalgogrin, and 6 from Buddigower. It was found to extend over a belt of granite at intervals for about 9 miles.

The prospector sank five shafts to depths ranging from 15 to 75 feet. The first three disclosed tin ore; Nos. 3 and 4 disclosed ore in a connecting drive at 35 feet. Nos. 4 and 5, 100 feet apart, were also connected by level. The average width of lodestuff disclosed was about 10 inches. About 30 tons raised from the above workings, 13 of which were treated at the True Blue battery, Wyalong, for a return of 1 ton 1 cwt. 1 qr. 4 lb. of concentrates (yielding 57·9 per cent. of metallic tin), equal to 8·18 per cent.

Other parties are reported to have discovered encouraging prospects, but found water scarcity a great drawback. Wolfram was also reported.

Later in the same year the site was examined by J. B. Jaquet, who reported :—

> "Cassiterite in *situ* has been traced for a distance of 300 feet. It occurs both in reefs and distributed in the granite country. The reefs hitherto treated are composed of pure white quartz, and are remarkably free from impurities of any kind. In all the specimens which I examined the tin was coarse, and in no instance finely disseminated throughout the ore. I obtained from one reef two massive specimens of cassiterite weighing several pounds. So far as the little work done enables me to judge, they are likely to prove lenticular in character—that is to say, there has been discovered on the field a number of reefs of limited extent, arranged more or less in a line, and not one long continuous lode. It has yet to be determined whether the country intervening between, and in the immediate vicinity of, these reefs carries tin in sufficient quantity to enable these seemingly scattered ore bodies to be mined as one deposit. Given a good supply of water, the ore presents no difficulty on the ground of treatment. I would point out that very little work had been carried out on the field, the deepest shaft at date of my visit being less than 30 feet."*

In 1907 E. Connolly had 57 tons of ore treated at Wyalong for 2 tons of concentrates, equal to $3\frac{1}{2}$ per cent. The site was examined this year by L. F. Harper, who described it as follows †:—

> "The country rock, a granite varying from coarse to very fine-grained, is highly weathered to the depth so far penetrated, and can be easily dug with a pick and shovel. The reefstone is mainly quartz, containing cassiterite in a varying state of association, from crystals half an inch in diameter to a very intimate admixture of quartz and tin oxide. Arsenical iron and copper pyrites occasionally occur in the quartz, and a sample carrying these minerals was assayed in the Departmental Laboratory, with the following result:—
>
> "Gold ..... 1 dwt. 2 grs. per ton.
> Silver ..... 7 ,, 5 ,, ,,
> Copper ..... 0·25 per cent.
> No tin detected."

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* Ann. Rept. Dept. Mines for 1896, p. 74. † *Ibid.* 1907, p. 173.

Aid from the Prospecting Vote was granted to sink shafts B and D to 75 feet, and to crosscut at that level. From one of these the lode was cut at 6 feet from shaft.

A level was driven at 30 feet between shafts A and B, and 20 tons of ore stoped out.

The reef, according to Mr. Harper, varied from 3 ft. 6 in. in width down to nothing, the channel only being visible, but the main tin-bearing portion was not more than 7 inches. Considerable hand-picking was necessary to reduce cost of cartage.

In 1908 30 tons of 7½ per cent. ore were extracted. A new shaft was sunk 40 feet and driven 40 feet, lode averaging from a few inches to 4 feet in width.

In 1909, after extracting one crushing, the prospector abandoned the site.

Grenfell Division.

The first reference to tin ore in this division is the allusion in Mines and Mineral Statistics (1875, p. 119) to a fine sample of toad's-eye tin from Grenfell, at the Metropolitan Intercolonial Exhibition of 1875.

Stream tin was reported at Native Dog Ranges in the Grenfell district in 1876.*

The following notes on tin occurrence in this division have been supplied by Mr. W. H. Hazelton, Warden's Bailiff, Grenfell, who possesses an intimate knowledge of the local mineral resources.

Arramagong.—About 13 miles south of Grenfell, near centre of eastern boundary of Portion 17, Parish Tyagong, County Monteagle. Granite country. A little stream tin obtained, but not in profitable quantity. Byrne and party worked here about 1906–7. Sinking, 30 to 40 feet. Tin coarse, but not waterworn.

Eureka Lead.—9 miles S.E. of Grenfell, on Reserve No. 18,812, Parish Coba, County Monteagle. Three feet of alluvial wash struck at a depth of 240 feet from the surface, carrying gold and a small amount of stream tin; not payable.

Milkman's Lead.—1 mile east of Grenfell, Parish Brundah, County Monteagle. A little stream tin was obtained whilst working the above auriferous lead. Depth, 100 feet; wash, 1 foot thick.

Native Dog Lead—also known as *Native Bear.*—Portions 23, and C.L. 2,032, Parish Wallah Wallah, County Forbes. A little toad's-eye tin was obtained here from alluvial gold working, but soon gave out. Worked in a level 180 to 200 feet below surface.

Quondong Lead.—4 miles S.E. of Grenfell, Parish Brundah, County Monteagle. A little stream tin obtained here in gold wash, at 150 feet from surface; wash, 18 inches thick.

Star Gully.—Parish Brundah, County Monteagle. Lode tin was found in decomposed granite at the junction of slate, near the head of Star Gully. Fritch and party obtained a small quantity from a lode 3 feet wide; striking N. and S., and dipping slightly to the west. It runs parallel to Payne party's lode, and is traceable for some distance, but is only slightly stanniferous. Stream tin was found a little further down the gully. A sample yielded 56·96 per cent. of metallic tin.

Aid was granted for Payne's lode, 10 chains south of Star Gully, and 1 mile N.E. of Grenfell. This lode has a width of 3 feet, two of which carry

* Ann. Rept. Dept. Mines for 1876, p. 57.

very slight quantities of fine-grained tinstone disseminated through quartz. It occurs in acid granite near junction of slate. Shaft, 25 feet deep. A sample of the lodestuff yielded 0·24 per cent. metallic tin.

Two-mile Lead.—2 miles S.E. of Grenfell, Parish Brundah, County Monteagle. A small amount of stream tin was won with the gold from this lead. Depth to wash, 150 feet; wash, 1 foot 6 inches thick.

Wallace's Gully.—1 mile N. of Grenfell, Parish Brundah. A little stream tin obtained at a depth of 80 to 100 feet; worked by a drive. Channel only a few feet wide; wash, 6 inches thick.

Dubbo Division.

Talbragar River.—10 miles N.E. from Dubbo, Parish Beni, County Lincoln.—Tin ore in gold-bearing wash, associated with platinum, monazite, and zircons, was obtained in prospecting drift under basalt at the above locality, but the results were not remunerative.*

(*h*)—Coastal Districts.

Coastal Deposits.—Tin oxide, in an extremely fine state of division, occurs sparingly on the beaches of New South Wales, and in beach sand accumulations, notably between Byron Bay and Clarence Heads, and in lesser quantity between Port Macquarie and Cape Hawke, near Seal Rocks, at Shellharbour, Termeil, &c.†

It is associated with zircon, garnet, ilmenite, monazite, gold, and platinum.

In working for gold, where the natural concentration by past and present wave-action rendered it payable, the tin, monazite, gold, and platinum were recovered on carpet-covered tables, which experience—both in this State and New Zealand—proved the most effective gold-savers. After treatment with hot caustic solutions to remove the organic film—arising from the swampy conditions of occurrence—the gold was separated from the concentrates by ordinary amalgamation.

Several attempts have been made to recover the valuable constituents of the sands by machinery, but, so far, unsuccessfully; the latest is by means of a pumping plant on the dredging principle, installed by the Société Industrielle Francais des Sables Metalliféres at Jerusalem Creek, between Clarence and Richmond Rivers.

The fineness of the component parts of the metalliferous layers may be judged from the fact that 57 per cent. of the natural wash from one of the principal claims at McAuley's Lead, passed readily through a mesh of 8,100 holes to the square inch, whilst 86 and 87 per cent. of the carpet concentrates passed through the same screen. Most of the quartz sand, however, was retained on a screen of 3,600 holes to the square inch. It is doubtful whether these deposits will furnish an appreciable quantity of tin-ore. The practice—whilst gold was won—was to ship the small amounts of concentrates abroad, where they were treated for platinum and tin, and possibly monazite, though the thoria contents of the latter are low.

The presence in the coastal sands of the metals and metallic minerals enumerated has been variously accounted for locally, the favourite view ascribing a submarine source. In the Writer's view they have been derived from past and present drainage channels from the eastern margin of the auriferous and stanniferous rocks of the New England tableland, which forms the watershed. The channels have a precipitous fall from the above forma-

* Records Geol. Survey N. S. Wales, VIII, 1909, p. 275.

† See Reports by J. E. Carne (Ann. Rept. Dept. Mines for 1895, pp. 149–160; and 1896, pp. 102–107).

tions and short courses to the sea. They are very subject to flooding in rainy seasons, the currents at such times being swift and powerful. The lower stretches of these rivers have little fall, and here the heavier burdens from the precipitous upper reaches are dropped, whilst only the finer particles are swept on to the sea.

Where the watershed is formed of rocks differing from those above mentioned (as west of Sydney, where the Hawkesbury Series (Trias) and the Permo-Carboniferous Measures form the high lands), the characteristic auriferous sand is absent from the coast beaches.

Taking all the facts into consideration, it seems most probable that the earlier drainage channels (represented by the drifts under the basalt flows), and the present surface streams have been, and are, the feeders of the auriferous beaches.

The early drainage channels probably first began the work of transporting the sand to the sea, and it is now carried on by the present drainage system. Owing to the extreme fineness of the particles, the powerful currents of these old torrential rivers, like the present, were able to overcome the high gravity of the component minerals and sweep them on to the ocean, where they encountered an opposing current and the shoreward sweep of the waves.

Since the basalt flow filled up these early rivers and turned the waters into new channels, atmospheric denudation has been steadily wearing away the volcanic cover and bringing the imprisoned drifts again within the transporting influences of rain and stream to the further enrichment of the beaches.

*Tin Ore in the South Coast and adjacent Districts.**

Though tin mining is practically confined to the Northern Tableland, yet it was on the southern, near Kosciusko, that the Rev. W. B. Clarke obtained his first sample of Australian tinstone (*vide* report, dated 24th December, 1851).† Having previously predicted (*Sydney Morning Herald*, 16th August, 1849) its discovery along parts of the Upper Murrumbidgee, he also recorded a further discovery of tinstone in New England, in a report dated 7th May, 1853.

Tin ore, in the form of loose grains in alluvial drifts and in beach sands, has long been known in the South Coast districts, but nothing payable has yet been discovered; nor until quite recently, has it ever been traced to its source. Of the alluvial occurrences, those of Tantawanglo Mountain near Cathcart, and of Tanja near Bega, are the best known. Of the littoral type, Shellharbour, Termeil (opposite Brush Island), and the coast opposite Tanja, have attracted most attention. In physical characteristics, association, and mode of occurrence, the tin ore of the Southern beaches closely resembles that of the North Coast.

The Tanja and Cathcart stanniferous areas are close to the east and west borders of the extensive granite belt extending from the Victorian Border to north of Cobargo. The eastern margin junctions intrusively with Devonian sedimentaries, the western with Ordovician.

In 1899–1900 an attempt was made by the Monaro Tin and Gold Mining Company to follow superficial prospects near Cathcart into deeper swampy ground, to prove the existence or otherwise of workable deposits. Operations, however, ceased after the fruitless expenditure of several hundred pounds in cutting head and tail races, erecting siphon, sluice-boxes, &c., and of subsequent aid from the Prospecting Vote, in cutting a trench through a swamp.

* Since this work was in type tin ore has been discovered by S. Edmunds and J. Sitruc, in M.L. 1 Ph. Admirrah, Co. St. Vincent, close to the Milton–Nowra Road. † Southern Goldfields, 1860, p. 128.

In 1900, a party of four men were aided from the Vote to prospect the district from June to October. Samples of tin ore were received and assayed; but, being concentrated, they were no criteria of the value of the drifts tested. Nothing further has transpired connected with tin prospecting in this locality, which lies about 4 miles east of Cathcart.

The Tanja stanniferous locality is situated about 5 miles north-east of Bega, on the eastern slopes of the Dr. George, or Mumbulla, granite range, which trends from the coast near Tathra, north-westerly to the Monaro Tableland. Between the range and the coast, Devonian sedimentary rocks extend, intruded in places at Tanja by diorite, the decomposition of which has fertilised the neighbourhood. The granite is of a highly acid type, the absence of the darker basic minerals being very marked.

The discovery of tinstone in the drifts at Tanja (or Nelson) gold workings was practically coincident with the opening of the field over twenty years ago, but no serious attention was paid to the tin ore itself until comparatively recently.

About 1897, Mr. D. Kiss endeavoured to trace the source of the drift tinstone in Sandy Creek, but was unsuccessful. In 1904, however, Messrs. Meaker Bros., in conjunction with Mr. Kiss and others, succeeded in locating two or three thin veins of quartz and tinstone in the granite, about 3 chains from the creek, by "loaming" up the slope of a small spur terminating in an angle formed by the main creek and a tributary, the site being about one mile and a half above the gold workings in which tin was first observed. A shaft, sunk in rotten granite to a depth of 23 feet, revealed a joint crack containing a mere thread of quartz, with a little tinstone. About 20 feet from the shaft, an open cut was made in very hard unweathered granite. At 10 or 12 feet in depth, the vein split into two or three strings ranging from $\frac{1}{4}$ to 1 inch thick. Before dividing, the greatest thickness was about 3 inches of quartz and tinstone. Both horizontally and vertically, the thin joint fillings are very capricious in occurrence. About 10 feet west, a mere thread of quartz with traces of tinstone occurs, and 18 inches beyond it, an inch vein of pyritous quartz, said to yield 2 dwts. of gold per ton. The open cut exposes the principal vein or veins for upwards of 16 feet without improvement. The mode of occurrence—as thin inconstant joint fillings in very hard granite—and the absence of any indication of master-jointing or true fissuring, or lateral impregnation of the granite itself, is unfavourable for the occurrence of workable deposits. The absence, also, of any appreciable quantity of liberated or drift tin ore in the adjacent channels, notwithstanding a very considerable amount of denudation, and natural ground sluicing into them, appears to be conclusive evidence of the inherent poverty of the granite. An idea was entertained that the veins might come together and form a lode at a depth, but there are no indications in support of it; on the contrary, the conditions of occurrence are antagonistic to such a contingency. The main vein strikes N. 40 W., and dips S. 50 W. at 27 degrees from the vertical.

One hundredweight of picked stone, obtained from the open cut, is stated to have assayed 13 per cent. metallic tin; but the percentage proportional to the amount of material excavated would be insignificant.

In 1896–97, during the operations of the Border Prospecting Party, the Writer obtained a little tinstone in drift from a 45 feet shaft, sunk near the Victorian Border, west of the Eden-Genoa road.

Both lode and stream tin ore have been found near the Pilot Mountain, on the Main Snowy Range, near the Victorian Border. The first notice of discovery is recorded in *Iron* (vol. V. 1875, p. 551). About 10 lb. weight of

stream tin ore intermingled with about half-an-ounce of rough reef gold, is mentioned as being obtained from fifteen loads of wash-dirt near the foot of the mountain, the formation being described as superficial deposits on granite.

The locality was subsequently inspected by W. Anderson, Geological Surveyor, in March, 1892, who stated that a good deal of alluvial tin had been obtained in the neighbourhood of the site for which aid was asked from the Prospecting Vote, situated about 3 miles from the summit of Mount Pilot—this mountain has an elevation of 6,020 feet above sea-level. Numerous shafts had been sunk from 30 to 40 feet in a stanniferous quartz vein, varying in thickness up to 1 foot. It occurs close to the junction of granite and slate. Aid was granted to continue sinking to 135 feet, but was not availed of, operations not being resumed. The site was held as M.L. 1 of 20 acres, Parish Beurina. County Wallace.

Lode tin ore has been verbally reported by Mr. G. F. Litchfield (formerly of Matong, Snowy River), as occurring in slate a little south-west of the junction of Purgatory and Stony Creeks, Parish Napier, County Wallace. Also in or near Portion 101, Parish Matong, in the same county. A shaft was sunk in the latter site to a depth of 68 feet on a 9-inch reef, which is reported to have yielded 10 per cent. of tin at the surface, but gradually decreased in value with depth.

The following assays were made of samples from this locality :—

No. $\frac{3}{9}\frac{3}{8}$ Gossanous ironstone yielding 2·52 per cent. of metallic tin.

No. $\frac{2}{0}\frac{7}{0}\frac{0}{0}$ Concentrates containing tinstone, crystallized quartz, and rolled zircons, yielding 59·77 per cent. metallic tin.

From Cooma District a sample of amphibolite was received which yielded 0·54 per cent. metallic tin.

Adaminaby.—Cooma Division. Professor Liversidge recorded tin ore from this locality in 1882, but no particulars are given.*

Beresford.—Bombala Division. (*See* Cathcart).

Bungonia.—(Berrima Division)—Stream tin ore was discovered by Styles Bros. of Bungonia, near that village, in 1868. Its identification led to the first prospecting for that mineral in the State, by C. S. McGlew and others. After two campaigns, occupying several months, the attempt to locate payable ore was abandoned. In all, about 150 lb. of stream tin was won from shallow patches of drift, at no distance from the Bungonia Limestone Caves.

The occurrence of tin ore in this district was further recorded by Professor A. M. Thompson.†

The discovery in July, 1908, of stannite (sulphide of tin) at Tolwong in the Shoalhaven River Valley, not far from Bungonia Caves, adds to the interest of this historic occurrence.

Professor Liversidge also records that :—

> "A vein of tinstone one inch thick, was being worked near Bungonia in 1870."‡

In 1883 a sample from near Bungonia yielded 74·9 per cent. of metallic tin.§

In 1904 two parties were prospecting with unprofitable results. A little alluvial tin was found by L. Guymer on the southern boundary of the Caves Reserve, about 1½ miles S.W. of the Cave Cottage.

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* Min. Prod. N. S. Wales, 1882, p. 102. † Trans. R. Soc. N. S. Wales, 1869-70, pp. 69, 70.
‡ Mineral Products N. S. Wales, 1882, p. 102. § Ann. Rept. Dept. Mines, 1883, p. 31.

Cathcart (Bombala Division).—As above stated tin ore in small quantity has long been known near Cathcart.

The latest attempt to exploit these deposits occurred during the recent tin boom, when dredging operations were mooted. A sample of concentrates from Burke's Annual Lease, Parish Cathcart, County Wellesley, tested in 1909, yielded 60·06 per cent. of metallic tin, and gold, 13 oz. 17 dwt. 3 gr. per ton. As the amount of material treated to obtain the small sample of concentrates forwarded was not stated, it affords no criterion of value. (See also "Tantawanglo.")

Jindebyne (Cooma Division, Jindebyne (or Jindebain, according to the Rev. W. B. Clarke's reference) was the site of that authority's first discovery of tin ore in New South Wales. Writing on December 24th, 1851,* he records :—

> "I obtained one small specimen from the granite ; none was, however, found amidst the detritus."

In 1885, Mr. A. Sturgeon presented tin ore from near Jindebyne to the Mining Museum.†

Mt. Pilot (see p. 282).

Mowamba, about 6 miles south of Jindebyne (Cooma Division)—Probably identical with Mowembah, where tin lodes or veins are mentioned as occurring‡ Also with "Moamba" of the Rev. W. B. Clarke, in connection with stanniferous granite.§

The Mowambah tin occurrence was examined by J. B. Jaquet in 1896, and described in the following terms :—

> At Mowambah, about 6 miles south of Jindebyne, tin was discovered in quartz, a few years ago. All the workings were abandoned, and I was only able to examine the lodes upon the surface. They appeared to me to be short, and not of great extent. I picked out from the heaps some good specimens of tin ore, consisting of coarse blebs of cassiterite embedded in white quartz, I was informed, however, that this rich ore only occurred in small pockets. A few bags of alluvial tin were obtained from the creek below the reefs.‖

Sandy Creek (Tumut Division).—Parish Coolamon, County Buccleuch, about 18 miles east of Tumut.

The first reference to the occurrence of tin ore in this locality occurs in 1875,

> "Tin has been found 12 miles distant from Kiandra in the granite country, and several leases have been taken up. The ground has been fairly tested, and lodes of grey streak tin have been opened, but none of the ground is being worked at present."¶

In 1882 it was announced that Fitzgerald Bros. obtained 1¼ tons of stream tin from their gold claim at Sandy Creek.**

In 1900 the Writer visited Sandy Creek, and recorded that during gold sluicing operations in the bed of this creek a little stream tin ore has been obtained for a number of years past, increasing in quantity as the channel was worked up nearer the source of supply. The amount, however, has never been very appreciable at any time, and at present, under most favourable

* Southern Gold-fields, 1860, p. 128. † Ann. Rept. Dept. Mines for 1885, p. 142. ‡ Liversidge, Min Prod. N. S. Wales, 1882, p. 102. § Sed. Form. N. S. Wales, 1878, p. 26. ‖ Ann. Rept. Dept. Mines for 1896, pp. 133–134. ¶ Mines and Minerals Statistics, 1875, p. 23. ** Ann. Rept. Dept. Mines for 1882 p. 23.

conditions of situation, the annual clean up of a ground sluice affords only about one ton of clean tin ore, an amount which might be doubled if a more efficient water supply rendered effective work continuous during the period mentioned. Operations, as at present conducted, afford sufficient indication of the proportionately slender yield of the creek wash.

A short distance above the highest sluicing claim obtaining tin ore, all trace of it ceases, according to local report. This fact, and the occurrence of occasional specimens of lode tin (in quartz) induced a little perfunctory prospecting for lodes or veins along the eastern flank of a granite ridge trending parallel with the creek for a short distance below the point mentioned. An attempt to locate the source of the loose lode specimens by sluicing a considerable area up the bed of a small gully failed in its object.

Still higher up the flank of the ridge a small quartz vein was subsequently discovered by a Mr. Muir, who opened it to a depth of 14 feet, the thickness varying from 2 to 4 inches. The tinstone is sparsely distributed in the quartz, and might easily be overlooked, owing to its dull colour and lack of lustre. It is associated with chloritic material and black quartz. The latter is a marked feature in the Sandy Creek wash, but is by no means a certain indication of the tinstone, as it occurs abundantly without the latter.

At a later date aid was granted Messrs. Field and Bell, on the recommendation of Inspector Godfrey, to continue a tunnel into the ridge at a point lower down the creek. At 168 feet a 6-inch vein containing a little tinstone was reported. Though I was unable to verify its occurrence by inspection or examination of the tip material, it may be the continuation of the small vein already described which strikes in that direction. Further aid to drive upon it, and to continue cross-cutting, was not availed of, the encouragement not being sufficient.

Between the course of the vein and the main creek, prospecting shafts in the small intervening breaks and gullies failed to discover any payable tin ore, which might reasonably be expected if extensive lodes, or a stockwork of small veins, occurred in the ridge.

In view of the local evidence of extensive denudation, and the extremely limited quantity of tinstone liberated, the prospects of payable deposits in this particular locality are not hopeful.

During the dredging boom of 1903, the New Argalong Gold and Tin Dredging Company completed construction of a suction dredge on Sandy Creek, at a cost of about £4,200.

Dredging started on 22nd December of that year.*

During 1904 dredging continued for seven-and-a-half months, and then ceased. About 6,000 cubic yards of material were treated for a yield of 34 ozs. of gold and 15 cwt. of tin ore, of a total value of £368.†

No work was done in 1905. In 1906 it was reported that the Coolamon Sluicing Company, Limited, had a small plant in operation at Argalong, presumably the same locality. During the year about 30,680 cubic yards were treated for 233 ozs. of gold; no mention being made of tin.‡

In 1907 the Argalong Company suspended operations in June. During operations it was estimated that 56,289 cubic yards were treated for 223 oz. of gold; and tin ore to the value of £170. Being unremunerative, operations ceased.§

* Ann. Rept. Dept. Mines for 1903, p. 29. † *Ibid*, 1904, p. 26. ‡ *Ibid*, 1906, p. 26.
§ *Ibid*, 1907, p. 28.

Shoalhaven River—Nowra and Braidwood Divisions.—In 1872 the Rev. W. B. Clarke recorded that :—

"Tinstone has been found loose in the bed of the Shoalhaven River, but the actual lode has never been discovered."*

The local Mining Registrar alluding to the above, added :—"I look upon the two leases lately taken up for tin at Comarong Island as mere nonsense."†

The occurrence of stannite at Tolwong, in the Shoalhaven Valley, is referred to on p. 344.

Tantawanglo Mountain—Bombala Division. (*See* also Cathcart.)

In 1889 a find by Messrs. F. and C. Wiles of stream tin under swampy conditions was recorded.‡

In the following year it was announced that little had been done to prove the locality. Leases had been taken up close to the Eden–Bombala road. A Government prospecting party found patchy deposits of unpayable stream tin in places near the range. Mr. H. M. Joseph employed men to prospect his freehold and leasehold areas.§

The Mining Registrar in the same year reported that the four men appointed by the Prospecting Board in June to prospect for minerals at Tantawanglo, carried on operations until 8th October north of Portion 195 and M.L. 4, Parish Cathcart, County Wellesley ; and Budgery Swamp, south of J. Harper's Portion 189 in the same parish. Stream tin was found to be distributed in most of the gullies, but not in payable proportions. The party also prospected near Cowra bridge, on road from Tea Gardens to Tantawanglo, but found only small quantities of tin ore, with colours of gold.‖

In 1891 the Warden reported that the swamp in portion 52 (Parish Cathcart) and M.L. 4, were tested in several places ; very good prospects being reported from ground 11½ feet deep. Tin ore, similar in quality to that obtained by the Government prospecting party, was obtained.¶

In 1900, 80 acres were reported to be held in this locality, eight men being employed cutting races, installing fluming, &c., but nothing resulted from the revival.

Yambulla—Yambulla Division.—A sample of black sand from Yambulla, close to the Victorian Border—was assayed in 1903—for a return of 13·88 per cent. of metallic tin.

The Writer in 1897 found a few specks of ruby tin ore in deep alluvial ground at Timbilica, not far from the subsequently discovered Yambulla gold-field.

(*i*)—Gundle Tin Mines.

Hunter and Macleay Mining District—Kempsey Division.

Gundle Tin Mines.—M.Ls. 1 to 22, Parish Bellangry, county Macquarie about 10 miles westerly from Rolland's Plains ; the nearest shipping wharf, on the Wilson River, being about 17 miles by road.

The first record of tin in this district occurs in 1891, when the Warden reported that it had been discovered during the latter part of that year in Parish Bellangry.**

The applications for leases by A. Rudder and others were, however, made in June and July, and the first surveys in September, 1891. During this year samples from Brill Brill Creek (the head waters of which traverse some of the leases) were assayed in the Departmental Laboratory for yields of 40 to 50 per cent. of metallic tin.

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* Journ. Roy. Soc. N. S. Wales, 1872, p. 30. † Ann. Rept. Dept. Mines for 1875, p. 88. ‡ Ann. Rept Dept. Mines for 1889, p. 85. § *Ibid*, 1890, p. 81. ‖ *Ibid*, 1890, p 82. ¶ *Ibid*, 1891, p. 91. ** *Ibid* 1891, p. 127.

When the Writer visited the locality in 1895, it was locally reported that tin was found in the above creek as early as 1880.

From the official records it is noted that prospecting continued during 1892, after survey of a number of leases; about 14½ tons of ore were raised. In 1893 only two leases were worked; and no further record appears until 1896, when it was announced that a Sydney syndicate had taken up land, employed men to prospect, and raised about 500 tons of ore of unascertained value.

In November, 1895, the Writer paid a short visit to the locality in connection with an application for aid from the Prospecting Vote.

The tinstone was observed to occur in horizontal "floors" of aplite; below these porphyritic granite occurred, but carried no tin values. The cassiterite was present in the aplite in joint cracks, and pockets; also evenly distributed through the mass in parts.

Rudder and party's 26 feet shaft—the deepest at that time—passed through the tin-bearing rock in a few feet from surface into porphyritic granite; and at 20 feet from surface encountered a chloritic rock containing a little tin oxide and fluorspar, about 4 inches thick, increasing to 18 inches. Water prevented further examination.

The Gundle lodes were first opened to shallow depths by Rudder and party in 1891. Messrs. Moffitt and Reid subsequently held them for nearly three years, and then resold to the original holders.

M.L. 1 was taken up by Connelly and party about 1893, after cancellation for non-fulfilment of labour conditions.

Between 6th December, 1892, and 21st June, 1895, the following consignments of selected ore from Gundle were sampled and sold to the Sydney Tin Smelting Works, through Harrold Bros., according to a return supplied by the late Mr. A. Rudder:—

Date.	Gross weight of Ore.	Concentrates obtained.	Assay Value of Concentrates in Met. Tin.	Net Realization.	Percentage of Concentrates.
	tons.	tons cwt. qr. lb.		£ s. d.	
6 December, 1892...	12	2 11 3 0	63·4	126 2 2	21·5
3 March, 1894	20	4 16 3 19	62·0	165 4 11	24·2
4 October, 1894.. ...	14	3 11 3 19	64·0	129 9 1	25·6
26 February, 1895...	25	6 19 0 17	63·0	326 0 1	27·8
30 March, 1895.....	15	3 8 0 0	64·0	163 4 0	22·6
21st June, 1895.....	12	2 14 0 3	61 0	82 14 0	22·5
Totals	98	24 1 3 22	.....	£992 14 3	.....

In 1897 the Jubilee Tin Mining Company is reported to have sunk eight shafts to 30 feet, raised 700 tons of lodestuff; and installed crushing and concentrating machinery to the value of £1,900, consisting of 15-head stamper battery and three Woodbury vanners.

In 1898 this Company raised about 405 tons of lodestuff, valued at £572. The tin oxide was reported to be very fine-grained, and difficult to save. Work was subsequently suspended, with the reported object of amalgamating with adjoining claims, and placing the property in the market for sale. The Gundle mine also employed a few men, and raised about 160 tons of lodestuff.

In 1899 only a small quantity of ore was raised.

In 1900 most of the leases on the field were amalgamated into the Gundle Tin Mining Company, Limited. The old system of mining was replaced by

quarrying; milling operations carried on during the last four months of the year yielded 10 tons 12 cwt. 1 qr. of concentrates, averaging 63 per cent. metallic tin.

Messrs. Salmon, Verge, and party also worked their leases by means of an open cut to a depth of 14 feet, with reported good results.

In 1901 the Gundle Mines, Limited, obtained suspension, owing to want of capital. Some additional machinery was introduced.

During 1902, 1903, 1904, and 1905, the Company's leases were worked on tribute. In 1906 full time was worked during early part of year, with varying success. Operations continued during the better part of 1907, a small margin only over expenses being obtained.

The Writer is indebted to Mr. John Gainford, General Manager, for the following particulars of output:—

> "The Office records show that since the Company acquired the mines, in August, 1900, and up to the 31st December, 1907, 8,106 tons of stone were put through the battery, yielding 163 tons 12 cwts. 3 qrs. 19 lb. of black tin (equal to 2 per cent.), which was sold to the Sydney Smelting Company here, and gave a net return of £12,056 8s. 6d. This tonnage includes ore mined both by the Company and the Tributors, but excludes the product of Rudder and party, who owned the leases before the Company."

The total amount of concentrated tin ore obtained from the field, so far as can be ascertained, therefore amounted to:—

187 tons 14 cwt. 3 grs. 13 lb.—realising a net return of £13,049 2s. 9d.

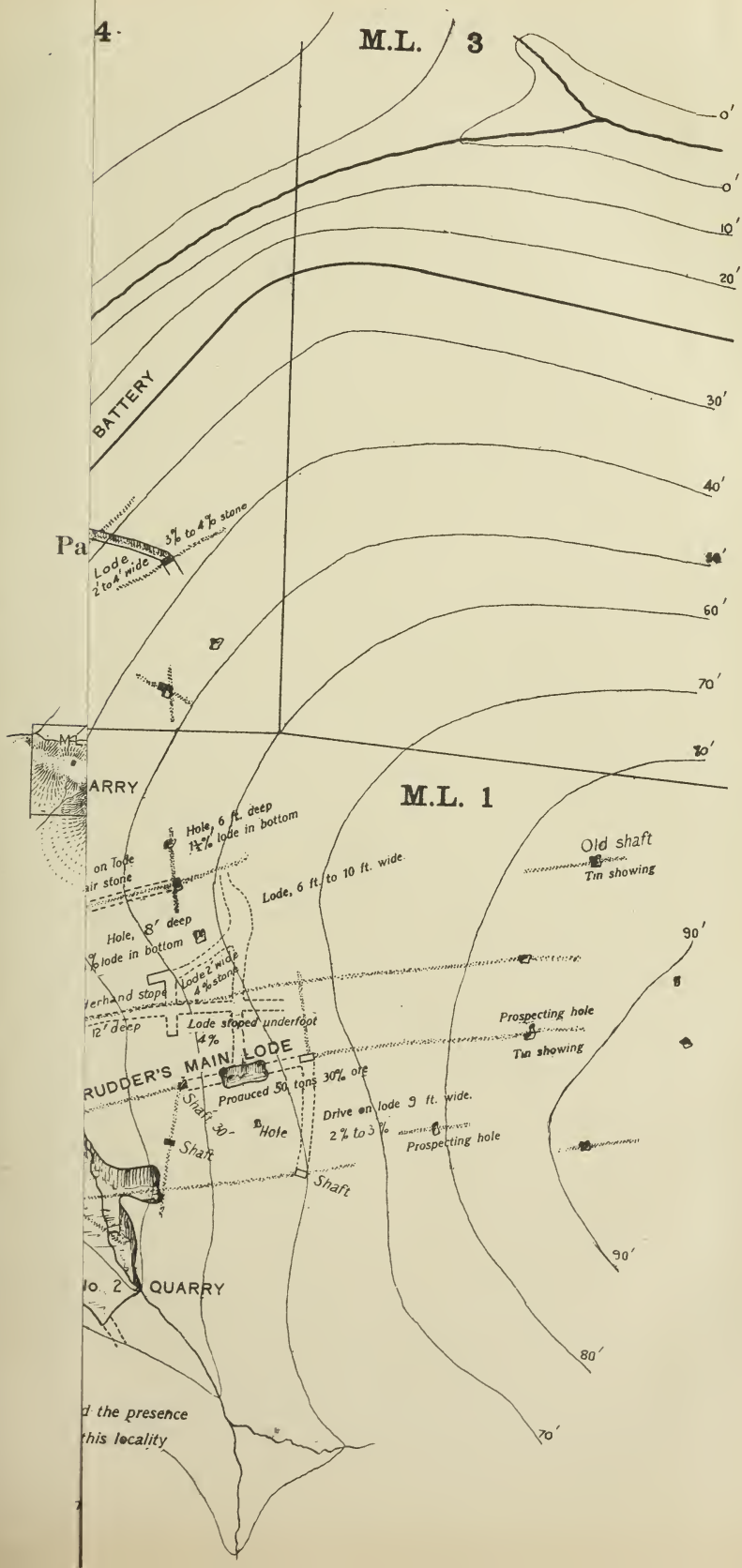
In 1906, Mr. G. A. Waller (formerly Assistant Government Geologist, Tasmania), examined the field and furnished a report, from which the following notes are extracted:—

> "The prevailing rocks of the district consist of ancient slates and sandstones, intruded by large dykes and masses of quartz-felspar-porphyry. Most of the tin ore obtained in the vicinity has been got from the latter rock, though there is no reason to believe that it is exclusively confined to it. The probabilities are that deposits of tin ore occur also in the surrounding sedimentary rocks. Up to the present, however, all work has been confined to the porphyry, an extensive belt of which occurs on the sections under review.
>
> "The tin occurs in the form of a net work of veins or lodes traversing the porphyry. These lodes cross one another without faulting, and as a rule form two series of parallel lodes intersecting each other at an angle of about 70 degrees. This feature indicates that the lodes have been formed along joint planes, the porphyry on either side of the joints being altered in character and impregnated with tin ore.
>
> "Like almost all tin ore deposits, the lodes in this mine are patchy. The tin-stone occurs in horizontal shoots or floors, thus although the joints from which impregnation has taken place are nearly vertical, the tin-bearing shoots are nearly horizontal, and cut out on the floor of barren porphyry. If this floor is sunk through a second horizontal shoot or layer of ore is found underneath, and so on.
>
> "From the plan attached to this report it will be seen that a large number of these lodes have been worked, and that the area of known tin-bearing ground is very extensive. All the workings are shallow, as the tributors who have worked the ground were not in a position to make any outlay on development work.

GUNDLE TIN MINE

Sketch of workings *After G.A.Waller*

e 0 50 100 Feet



Plan showing position of leases

Parish of Bellangry County of Macquarie

Scale 0 20 40 Chains

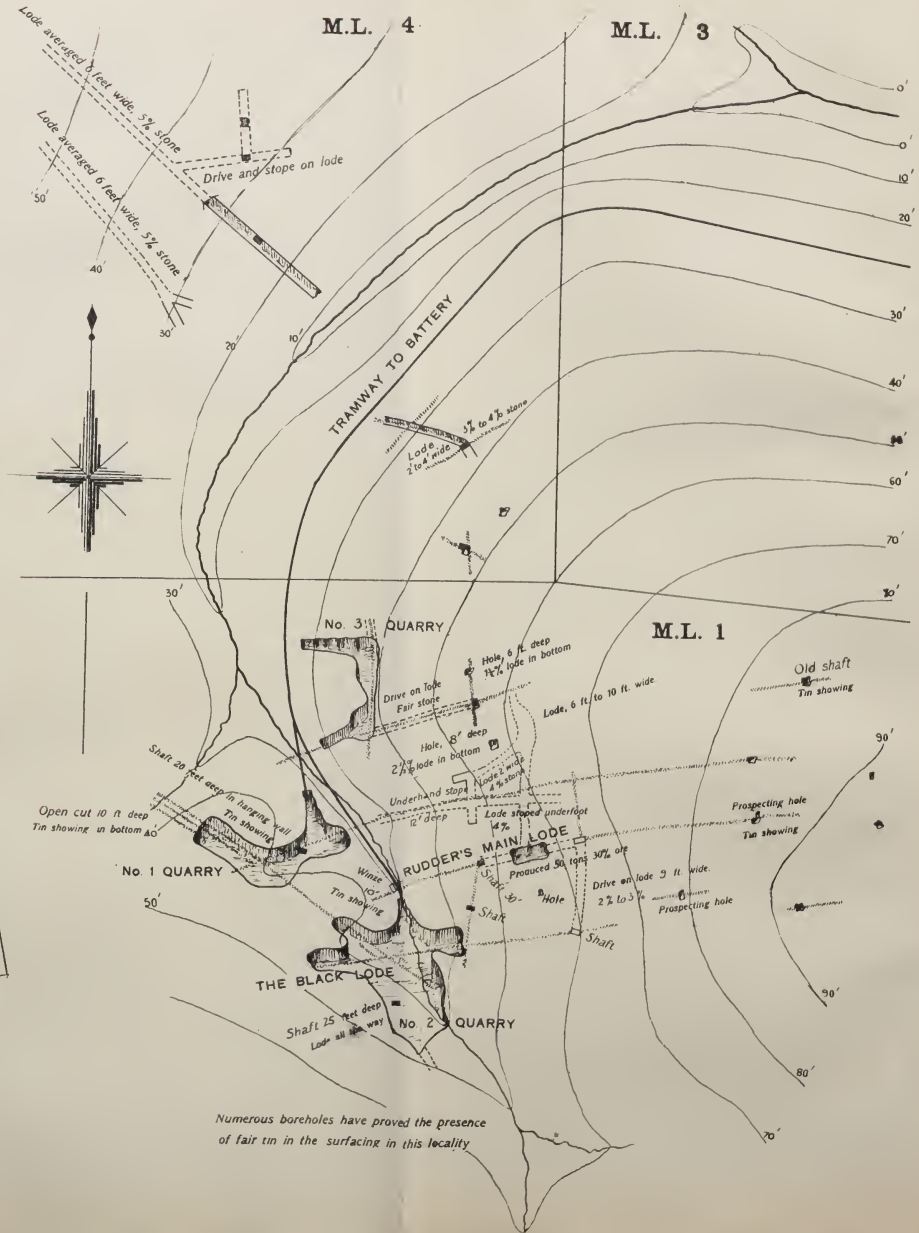
78094

THE GUNDLE TIN MINE

Sketch of workings

After C. A. Waller

Scale 0 50 100 Feet


M.L. 4
M.L. 3
M.L. 1
Lode averaged 3 feet wide, 5% stone
Lode averaged 6 feet wide, 5% stone
Drive and stope on lode
TRAMWAY TO BATTERY
Lode 2 to 4 ft wide
3% to 4% stone
No. 3 QUARRY
Hole, 6 ft. deep 1½% lode in bottom
Drive on lode Fair stone
Lode, 6 ft. to 10 ft. wide
Hole, 8' deep 2½% lode in bottom
Lode 2 ft wide 1½% tin
Underhand stope 12' deep
Lode stoped underfoot 4%
Old shaft
Tin showing
Shaft 20 feet deep in hanging wall
Tin showing
Open cut 10 ft deep
Tin showing in bottom
No. 1 QUARRY
RUDDER'S MAIN LODE
Produced 50 tons 30% ore
Drive on lode 9 ft. wide. 2% to 3%
Prospecting hole
Tin showing
Winze 10'
Tin showing
Shaft
Hole
Shaft
THE BLACK LODE
Shaft 25 feet deep
Lode all the way
No. 2 QUARRY
Numerous boreholes have proved the presence of fair tin in the surfacing in this locality

"A large proportion of the stone crushed was obtained from open quarries. In these places the veins of ore were so close together that the whole rock was taken out, and after a rough hand-picking, was sent to the battery. The best results were obtained by underground mining, and this appears to me to be the best method of working the mine. The underground work done on a number of the lodes has been quite satisfactory. The ore has returned from 3 per cent. to 5 per cent. black tin, and has been proved to occur in shoots from 2 to 8, and even 10 feet wide, from 10 to 15 feet in depth, and going up to 200 feet in length. The stone from the mine has been crushed in a small 10-head battery, fitted with very crude dressing appliances, in which the loss of tin and cost of treatment must have been high."

The Writer visited Gundle in September, 1910, but as active mining practically ceased in 1907, and work of any kind in 1909, opportunity for studying the underground developments was not available.

The open quarry faces, however, confirmed the opinion formed in 1895 of the horizontal occurrence of the tin-bearing aplite; and the barrenness of the porphyritic granite.

From the mode of occurrence of the ore-bearing aplite—as flat bands or "floors" in the non-stanniferous granite, and the close association of the tin ore, I am of opinion it is an intrusive "ore-bringer" in the latter, and therefore younger. The Gundle aplite is identical with those of the New England tin-fields, which are also later intrusions in the associated granites and sedimentaries.

Recently attention was directed to the most western outcrop—in M.L. 22—where aplite and quartz-porphyry intrude the sedimentaries in the form of a dyke. Tinstone occurs sparingly in the aplite, associated with a little copper pyrites. The width of the intrusive mass is about 100 feet, but the stanniferous portion is limited. The latter has been opened by several open cuts and a short tunnel. Picked stone was carted to the Gundle battery. The tinstone is very fine-grained and ruby-coloured. Samples averaged from the working faces yielded from traces to 0·35 per cent. metallic tin. The average of the whole being only 0·10 per cent.

The Gundle sandstones and claystones are of Lower Marine (Permo-Carboniferous) age. An interesting contact is exposed in No. 2 quarry, at Gundle, where a portion of the sedimentary series remains in flat contact with the stanniferous aplite, very similar to sections of identical contacts at Cow Flat, near Torrington, New England.

(*j*)—New England (Smaller deposits) and North Coast District.

Bald Nob, near head of Severn River, 16 miles from Glen Innes, on Grafton-road.

Tin-mining began at the head of the Severn in 1872, and has given employment to a number of fossickers ever since. Hogue's Creek, a tributary, near Mundee, was the scene of first operations in this locality. In 1875 a fair quota of stream tin was yielded by the River, Nine-mile Creek, Glen Elgin, and Bracker's Gully.*

Near Bald Nob the tin has been shed from numerous thin veins and joints in the granite, mostly associated with quartz and greisen; the tinstone is fine-grained.

In M.Ls. 3, &c., Parish Bloxsome, County Gough, several small rich patches of lodestuff were dollied by miners. A syndicate was formed in

* Ann. Rep. Dept. Mines, for 1875. p. 110.

1904, which took up the above leases, and erected a small Huntington mill and Imperial Worthington table, with 12 h.-p. engine and boiler, and No. 2 Dodger rock-breaker. Water was conserved in a small dam near by, from which it was pumped to a circular tank above level of plant. Work ceased, after intermittent running, in 1907, but the quantities of ore treated and tin won are not available, but are believed to have been very small.

The two principal lodes tested occur in the south block (M.L. 3). They strike N. 70° E., and have been opened to 60 feet and driven on for 80 feet at the 40-ft. level.

Water heavy, requiring pump. The lode is reported to vary from 1 inch to 4 feet, but it was impossible to verify owing to water standing at high-level.

Several shallow shafts have been sunk on the different lines of lode. Evidently the prospects did not warrant further expenditure.

Watson's Creek.—In 1879, E. F. Pittman briefly alluded to tin-mining at Watson's Creek, where he inspected some tin leases :

> "The tin has not nearly been worked out on this Creek in places. The workings were abandoned, chiefly because the depth of sinking (14 feet) would not allow of the profitable extraction of the ore at the then price of tin. This creek takes its rise in the range at a place called the Giant's Den, where the deposit was rich" *

In 1904, E. C. Andrews furnished the following report on the tin lodes of the locality :—

> "Giant's Den Tin Lodes are distant 42 miles north-west of Tamworth, via Bendemeer, and have an elevation above sea level of 3,700 feet. The country is the ordinary acid or tin granite of New England. Enormous quantities† of alluvial tin were originally found in the neighbouring Watson's and Giant's Den Creeks. These watercourses head in a flat-topped hill, known as Giant's Den Mountain, from which the alluvial tin has been shed. The summit of the hill consists for the greater part of a quartose greisen, in which abundant small white micas are developed. The occurrence is about 600 yards long and 300 to 350 yards wide. Numerous irregularly shaped masses of unaltered granite are scattered throughout the *greisen*. Several large masses of *mica rock* occur in the greisen. One of these, in which the only important prospecting operations have been carried on, is about 2 chains in length and 1 chain in width. A siliceous lode of small but very variable width traverses this mass of mica rock. No indications of permanency for this lode are visible at or near the surface. Both quartz and mica rock are lenticular in shape.
>
> "Two shafts situated close to each other have been sunk in the mica rock. One about 70 feet in depth was put down by McGlew and party some fifteen years ago. The bottom of the shaft has collapsed, but has been, in part, reopened by Rowland's party. Tin of splendid quality, associated with tourmaline and quartz, occurs in lenses below the 50 feet level. One of these lenticular masses worked partially by McGlew's party was said to be 3 feet in thickness. At the time of my visit, however, it was covered up by the debris in the shaft.
>
> "Numerous small white tourmalinised quartz veins varying from one-quarter to one-half inch in width across the greisen mass. In these tin also occurs.

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* Ann. Rept. Dept. Mines for 1879, p. 225.

† According to local report, the output, however, was not remarkable.—J.E.C.

"Several other outcrops containing tinstone and copper pyrites have been prospected within the greisen belt. The tin and copper contents of these lenticular patches, as also of the veinlets mentioned in the previous paragraph are not sufficiently concentrated to be at present commercially valuable.

"The tin deposits here as in other New England greisens will be found to be capriciously distributed, the more payable deposits being situated in the masses of mica rock. Owing to numerous requests on the part of New England miners to be informed as to the origin of these tin lodes and their associated placers, the following brief description is herewith supplied.

"The tin-bearing granites are very sandy, and support a very stunted vegetation, and may thus easily be recognised among the other igneous rocks, which at times support tall forests.

"When the latest granites rose to the crust they commenced to cool slowly downwards from the uppermost portions. Thus the top was consolidated while the underlying portions were still molten. As the granites cooled they contracted and cracked. These cracks at times penetrated the consolidated portions so deeply that the still molten residue below was tapped. This mother liquor below was highly charged with water containing large quantities of hydrochloric and hydrofluoric acids. Under the great pressure of the overlying rock masses, this water, or rather steam, was as hot as the rocks in which it circulated, and as such was able under the influence of its contained acids to hold many minerals in solution. Among these were bismuth, tin, wolfram, molybdenite, and gold. The action of these highly heated acid laden waters (carrying various minerals) as they ascended to the consolidated granite higher up, but still buried under thousands of feet of rock, was to completely change the granite in its neighbourhood to greisen, that is to a mass of quartz and white mica in which topazes were also formed. The felspars were changed to mica. Tourmaline and tin were also deposited, the tourmaline often taking the place of the quartz. Molybdenite, wolfram and bismuth also were frequently brought up by these highly heated waters (steam) and deposited in the greisen. Generally the tin is set free in the most highly altered portion of the granite, viz., the mica rock. As a rule, this mineralising of the granite occurs alongside or at the contact of the granites and surrounding rocks such as "trap," claystone, slates, or other and older granites. Thus the molybdenite, tin, bismuth, wolfram of New England occur characteristically at the margins of the granite masses.

"With the progress of time, the mountains were gradually worn down by the streams. Thus the tin veins occuring in the upper portions of the granite magmas were exposed, and in turn planed off by the streams. The greater portion of the lode contents were carried away altogether, being finally ground to dust in the watercourses during periods of heavy rain. A percentage, however, was deposited in the watercourses heading from the denuded tin lodes. Hence the origin of of the "placers." This fact also demonstrates the uselessness of expecting reefs to improve with depth, since the present outcrop of a reef represents that portion which originally existed thousands of feet below the land surface, and may therefore be reasonably assumed as representing the average value of the reef."*

* Ann. Rep. Dept. Mines for 1904, p. 144.

The progress of mining at Watson's Creek is indicated in the following brief notes from Departmental records :—

Leases were granted in 1883.

In 1884 dams were being constructed to conserve water for sluicing purposes.

In 1885 eighteen applications were received for tin-mining leases. The Perseverance Company was the only leaseholder raising tin ore, but the amount was not mentioned. The Bendemeer Tin-mining Company was testing their ground, making dams and erecting machinery.

In 1886, the Longford Tin Mining Company raised 5 tons of stream tin ore. C. Allen and party, 5 tons. At close of year work was suspended in Watson's Creek by the different companies, the ground proving too patchy to be payable.

In 1887, mining was confined to small parties who collectively raised 7 tons 13 cwt. of tin ore.

In 1888, the Watson's Creek Tin Mining Company's property and plant was offered at auction. No output returned.

In 1889, 26 tons were raised by mineral license holders.

In 1890, the Giant's Den Tin Mining Company won 20 tons, and small parties 10 tons 2 cwt. 2 grs. 18 lb.

In 1891, the Giant's Den Tin Mine produced 17 tons.

No record in 1892.

1893.—Produced 6 tons 16 cwt.

1894.—Tin ore to the value of £800—probably 13 tons 6 cwt.

1895.—11 tons 17 cwt.

1896.—12 ,, 2 ,,

1897.—11 ,, 11 ,,

1898.—No record.

1899.—9 tons.

1900.—12 tons. Scottish Australian Tin Mining Company, registered November, 1900; capital, £9,000; area, 220 acres.

1901.—13 tons 5 cwt.

1902.—10 ,, 0 ,,

1903.—21 ,, 13 ,,

1904.—15 tons.

1905.—12 ,,

1906.—11 ,,

1907.—19 ,,

1908.—14 ,,

1909.—No record. Little work done. In 1910 the Den Dredging Company won 20 tons of ore; and Farrell and Sain, 4 tons.

Total recorded output, about 285½ tons.

Bingara.—Wood tin, as a rare associate of the diamond in the Bingara diamond drifts, is recorded by Liversidge.*

Bolivia Creek, close to Bolivia Station Homestead.—Parish Bolivia, County Clive.

In 1899, alluvial tin was found by Willows and party in a gully running into Bolivia Creek; and about 1½ to 2 tons of stream tin were obtained, the country being biotite granite. Soon exhausted and abandoned.

* Journ. R. Soc. N. S. Wales, 1873, p. 88; also in Mineral Statistics, 1875, pp. 107, 111.

Commissioner's Creek.—North of Bulldog Range, between Lismore and the Tweed River.

Very light-coloured tin oxide reported by Mr. J. Mahony of Lismore.

Dandahara and Tin Ore Creeks.—Parishes Richmond, Binny, and Moogem, County Drake. South-west of Cangai Copper Mine, locally known as "Gibraltar."

From the high range west of Dandahra Creek, a sample of stream tin was shown the Writer in July, 1907. In July, 1909, two leases for tin-mining were taken—M.Ls. 4 and 5, of 80 and 40 acres respectively. It was also reported that a sluicing plant was being conveyed to the site.

Ding Dong.—Parish Parkes, County Clive. The occurrence of tin ore in this locality was described by C. S. Wilkinson, in 1883, in the following terms :—

> "At Ding Dong, near the junction of the slate formation and granite, the latter, which is coarse-grained granite, contains irregular shaped masses of greisen rock, composed of quartz and mica in varying proportions. These masses appear to have been formed by seggregation, and the tin ore occurs disseminated, though chiefly in bunches. I also saw small tin veins in the altered slates. In Portion No. 141, a shaft has been sunk to a depth of 30 feet, following down a greisen lode, which is from 2 to 3 feet wide. A joint runs through the centre of it dipping S. 30° E. at 57°, and at right angles to this are other joints across the lode, some of them being open with empty spaces 4 inches wide in places. The tin ore is in patches, and scattered crystals in a shoot 10 feet by 2 feet, following nearly the line of joint. It would seem as if the tin ore had crystallized from a solution or vapour, which penetrated the rock from the joint-fissure. Five of these masses of greisen containing tin, some with quartz veins have been prospected, and there are, no doubt, others not yet opened. Wolfram is sometimes associated with the tin. A gully drains from the hill in which these lodes occur, and at the foot of the hill it opens into an alluvial flat, in which there are probably payable deposits of stream tin. Some small tin lodes have also been found in the range near Back Creek, about 3 miles further east."*

Dundee and Paradise Creeks.—County Gough.

The Rev. W. B. Clarke's historic reference to the occurrence of tin-ore in New England concerns these localities :—

> "Wolfram and oxide of tin, with tourmaline, occur near Dundee and Paradise Creeks ; and it is probable that this ore of tin is plentifully distributed in the alluvia of other tracts, as I have found it amidst the spinelle rubies, oriental emeralds, sapphires, and other gems of the detritus from the granite."†

A further report dated 14th October, 1853, also alludes to the finding of tin.

Guy Fawkes.—In 1898 it was recorded that two experienced miners, working for a Hillgrove syndicate, discovered tin-ore at Guy Fawkes, but not in payable quantity ; it is also believed to occur under basalt about 2 miles distant.‡

Highland Mary Lode.—8 miles north-west from Glen-Innes, in Parish, Hadbury, County Gough.

Inspector Sawyer in 1905 reported several promising quartz veins carrying tinstone at this site. Aid was granted to sink 70 ft. from surface. The final report states that the shaft was sunk on a small vein of tin oxide, which either cut out, or passed out of shaft—no sign of it at bottom.

Ann. Rept. Dept. of Mines, 1883, p. 151. † Report No. 8, 7th May, 1853. Gold Discovery Papers, p. 345.
‡ Ann. Rept. Dept. Mines for 1898, p. 73.

Hogue's Creek, a tributary of the Severn River, which it joins at the villa of Severn. Tin-mining began here in 1872. In 1880 a rise in tin valu caused considerable activity, the old ground being reworked. 170 tons of ore were won in this year from ground varying from 4 feet to 20 feet in dep At the head of the Severn near Bald Nob, 81 tons were raised from grou averaging from 3 to 12 feet in depth. Fossickers still occasionally eke ou living in these old workings. The high lands on the east side of the Cr have furnished a good area of surfacing; much virgin surfacing yet rema but is only available when water is abundant. A noticeable feature is large amount of ironstone gravel on the terraces, resembling the concreti of poor bauxitic iron ore from decomposition of basalt.

Isis River, near head of, 30 miles north-east of Blandford. Tinstone v reported in this locality by W. E. Abbott in 1908.

In 1909 crystallized tinstone was also recorded by G. W. Card.*

Mann and Timbarra Rivers.—In 1875 it was recorded that—

> "On the Dividing Range between the Timbarra and Mann Riv several excellent tin lodes have been discovered. Very rich stream has been obtained on both sides of this range, but no work has been do on any of the lodes."†

In 1906 sluicing operations on a large scale were commenced on the ban of the Mann River, but with unsatisfactory results.‡

Pheasant Creek Lodes.—Portion 9, Parish Moogem, County Clive, abo 27 miles a little north of east from Deepwater. Examined by C. Wilkinson in 1883.

> "The tin lodes at Pheasant Creek, which are being opened by Pheasant Creek and the King Tin-mining Companies, are similar their mode of occurrence to those at Ding Dong, consisting chiefly detached blows of tin-bearing greisen in granite, and near the junct of the granite with metamorphic sedimentary formations."§

From a later report by Norman Taylor|| the following particulars extracted :—

> "From the surface wedge-shaped masses of lodestone (nearly p white mica) cut out below. The lode at present appears to run nea east and west, with a tortuous course, and is about 4 feet thick, with appearance of widening to the westward. At the present depth a la quantity of mixed sulphides is met with (galena, zincblende, and ir pyrites), together with chlorite and quartz on the western wall.
>
> "With regard to No. 6 shaft, I omitted to mention that this sha has proved the richest in tin yet. A quantity of ore sent down Sydney gave 60 per cent. of tin oxide, and the average would probab not be under 45 per cent."

Shannon Vale.—Six miles easterly from Glen Innes, in James Osborn and, Parish Beardy Plains, County Gough.

Inspector Carthew, in 1902, reported tin-bearing wash under basalt at th site. Aid was granted to drive a low-level tunnel 150 feet. Progress repor show that a little wash occurred in the last 80 feet of tunnelling, yieldi 2 oz. to the dish.

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* Records Geol. Survey N. S. Wales, VIII, 1909, p, 275. † Ann. Rept. Dept. Mines for 1875, p. 1
‡ *Op. cit.* 1906, p. 51. § *Op. cit.*, 1883, p. 151. || In Select Committee's Report of the Legislat Assembly on the claim of Matthew McIvor to a tin-mine at Pheasant Creek. (Printed 9th October, 1884).

On Edward White's land, 8 miles from Glen Innes by Grafton road, spector Carthew also reported tin under similar conditions. Aid granted tunnel 200 feet. Latest report at 160 feet wash dipping into hill; yield, oz. to the dish. No further report.

Skeleton Creek.—Parish Bald Nob, County Gough. This was at one time arge tin-producer. In 1882 122 tons 18 cwt. of tin ore were raised from uvial ground, averaging 15 feet in depth, and a width of 50 to 300 feet. e wash averaged 1 foot 6 inches in thickness.

Wade's Tin Lodes.—Parish Snowy, County Clarke, about 23 miles east of llgrove, between the Grafton Road and Oaky River, near Oakton Public hool, and 10 miles from Wollomombi.

L. F. Harper, who examined the lodes in October, 1910, states that the logical formations consist of a medium-grained quartz-felspar-biotite nite, intruding slates which are silicified and altered.

The cassiterite occurs as lenticular patches in more or less crystallized rtz reefs in the granite.

Two mineral leases have been surveyed to embrace two parallel lodes king about north-east and south-west.

In M.L. 1 a shaft has been sunk 50 feet on a quartz vein 15 to 18 inches ck, which in places is highly crystallised, but the cassiterite occurs in the orphous portions associated with mispickel.

A fairly rich shoot of tinstone was followed from the surface to 15 feet, lding 132 lb. of tin oxide. It gave out vertically, but was not driven on izontally. The lode itself pinched at the bottom of the shaft.

Tin has been proved in the outcrop by costeening for over 200 yards, and lode channel is traceable for about 40 chains.

About 4 chains east of the above-described another lode of similar char- er occurs, varying in width from 8 to 10 inches, which has been opened a depth of 50 feet.

No work has been done on M.L. 2. About half a mile further east a lode nation, about 30 feet wide, has been proved to contain gold and a little per. The copper occurs as carbonate stainings and grains of sulphide. ample assayed in the Departmental Laboratory yielded 17 dwt. of gold ton.

This formation strikes north-east, and has been traced for about 20 chains, further prospecting and sampling is necessary to prove its value.

About 1906 2 tons of stream tin are reported to have been won from one two creek beds intersecting the locality, whilst the prospector, C. Wade, obtained 14 cwt. during the past twelve months.

The stream tin is very little water-worn, and is fairly coarse, with asional pieces up to 2 inches in diameter.

Woodburn Division.—Tin oxide in an extremely fine state of division urs along the northern beaches between Seal Rocks and the Brunswick er, associated with gold, platinum, and monazite. In a few places, ably between Byron Bay and the Clarence, these minerals and metals have n so concentrated by wave action as to yield handsome returns to the first rators, In the large areas, naturally reclaimed by accumulation of sand es, between the Richmond and Clarence Rivers, several old beach lines e been discovered by boring, one of these—McAuley's Lead, Jerusalem

Creek, and Esk River—about three-quarters of a mile in places back from th shore line, yielded profitable employment to a large number of gold-miner for a considerable period*.

The fineness of the metallic and mineral particles may be gauged from th results of sizing tests therein recorded, as they readily passed through screen of 8,100 holes to the square inch.

The method of working, for the gold contents, adopted was that foun most suitable, both in this State and New Zealand, for this class of worl viz., carpet or plush covered tables; the coverings being frequently rinsed i tubs; the concentrates thus obtained being boiled in caustic solution t remove organic staining, then passed over amalgamated plates.

No serious attempt was made to save the tin and monazite sands unt about 1905, when the Société Industrielle Francais des Sables Métallifere started operations.

In 1909 it was recorded that an outlay of upwards of £14,000 had bee incurred, and the experience of the past four years proved, that unless larg quantities of sand could be quickly passed through the concentrating plan remunerative results could not be expected. Arrangements were, therefor being made for installation of a more powerful plant." During 1910, hov ever, practically no work was done.

(*k*)—Other Localities.

Mudgee Division.

Cooyal Station.—Parish Cooyal, County Phillip.

In 1876 C. S. Wilkinson reported:—

> "On Cooyal Estate (Mr. S. Blackman's) an auriferous lead has bee worked for some time; it runs through granite country, and contair tin ore in quantity almost sufficient to pay for collecting. This grani contains masses of cream-white orthoclase felspar, in cauliflower-lik bunches, through which are scattered crystals of smoky quartz. Son of these crystals are nearly a foot in diameter."†

In 1886 the same authority further recorded that:—

> "Tin ore of the concretionary variety called 'Toad's-eye' has bee obtained in small quantity in gold-bearing leads in the granite counti in Mr. S. A. Blackman's Cooyal Station."‡

Two-mile Flat.—Junction of Reedy Creek and Cudgegong River, ne Gulgong.

In 1870 "Wood Tin" was recorded as occurring rarely in the diamant ferous wash of this locality; and stream tin in the Newer Pliocene drift.§

Picton Division.

Mount Werong, 15 miles south of Oberon, Parish Banshea, Count Westmoreland.

The presence of tin ore in a small sample of concentrates in this localit was detected by J. C. H. Mingaye, in the Departmental Laboratory, b the record is only of interest as revealing its presence. The samp representing a small quantity of concentrates from an unknown quantit of wash-dirt.

No. 07.	1811—	Rare earths of the Cerium group as oxides	7·32 per cent.
		Thoria ($Th O_2$)	·27 ,,
		Metallic Tin	·40 ,,
		Fine Gold, 22 oz. 1 dwt. 2 grs. per ton.	
		Fine Silver, 1 oz. 12 dwt. 21 grs. per ton.	
		Platinum, less than 1 dwt. per ton.	

* Ann. Rept. Dept. Mines for 1895, pp. 149–160. † Ann. Rept. Dept. Mines for 1876, p. 174.
‡ (*Op. cit.*, 1886, p. 138.) § Industrial Progress N. S. Wales, 1870, pp. 575 and 577.

Lithgow Division.

In 1905, the Writer submitted the following report on the discovery of tin ore at Meadow Flat, near Sunny Corner :—

"I have the honour to submit the following brief report on the discovery of tin ore at Meadow Flat, near Sunny Corner, the exact locality being Portions 1 and 24, parish of Falnash, county of Roxburgh.

"The discovery was brought under the notice of the Department by the Hon. W. F. Hurley, M.L.C., who submitted a sample of the cleaned stream tin ore for assay, which yielded 73·46 per cent. of metallic tin. From inquiry it transpires that the "heavy black sand" was known for a number of years prior to its correct identification.* The late Mr. Dobbie, owner of Portion 1, and his sons had noticed it hanging back in the wash whilst prospecting for gold. Doubt having arisen as to its being "iron sand," Messrs. L. Dobbie and E. Sheppeard obtained and submitted for assay samples from Portion 1, when its real nature was discovered. Nothing, however, was done until Mr. Hurley visited the site, when a prospecting party, consisting of Messrs. Dobbie, Wearne, Sheppeard, and others, was formed to test the extent of the discovery. Operations had been in progress about ten days at the time of inspection under agreement with the owners.

"*Geology.*—The geological formations are granite, and quartzites and slates of Devonian age. Portion 1 is just outside, and Portion 24 just within, the south-west corner of the geological map of the districts of Hartley, Bowenfels, Wallerawang, and Rydal, by the late C. S. Wilkinson. Note 8 on this map describes the site as "fine-grained euritic granite, in which occur irregular masses of very coarsely crystalline granite, consisting of large crystals of felspar and quartz. . . . Near its junction with the Devonian beds the granite sometimes changes into felspar porphyry.

"The granite is intrusive in the Devonian beds, and at the junctions the sedimentary rocks are highly altered.

"Meadow Flat Creek and its tributaries receive the drainage of the Main Dividing Range on the east, and the Sunny Corner spur from it on the north. The watershed is wholly granite, and has suffered considerable degradation. The amount of material thus naturally ground-sluiced into the channels, by its concentrated stanniferous residues, should afford reliable criteria of the inherent richness of the country. Judging from the prospects so far obtained, the inference is that the tinstone is very leanly disseminated in the granite.

"The channels are shallow, with frequent "bars," which dam back the transported material, forming swampy flats. Just above these are excellent sites for testing the richness of the arrested wash, which, from its superficial character, could be easily tested in most places without insuperable water difficulties. If, however, payable deposits were proved, some, at least, of the bars would have to be cut through for tail-races to allow of ground-sluicing being carried on.

"The best results have been obtained in a small tributary in Portion 1, about a quarter of a mile above its junction with Meadow Flat Creek. Here the sinking is but 3 or 4 feet, and the wash about 8 inches, though

* The first published record occurs in 1888—(Liversidge, Minerals of N. S. Wales, 1888, p. 80).

a little tin-stone is lightly distributed throughout a greater thickne The best results average about 1½ to 2 lb. of stream tin to the load fr the bottom 8 inches of wash.

"The prospectors have constructed a sluice-box below a tempora dam in the creek, which enables them to make thoroughly satisfacto bulk tests.

"Seventeen loads taken from a few square yards of stripping e estimated to have yielded about 20 lb. of stream tin, the lower avera being attributed to the greater thickness (2 or 3 feet) of wash treated

"Higher up the channel, near the south-west corner of Portion tin ore in lesser proportion has been discovered in shallow ground on t edge of a swampy flat. As this flat is basin-shaped, and receives t drainage of a considerable extent of granite country, it is desirable th the deeper ground should be tested. If payable results were obtain the bar at the lower end would have to be cut through.

"Samples taken from the shallow ground yielded only a few grains tin ore to the dish, and a cartload yielded less than 1 lb.

"A superficial examination of the watershed of Meadow Flat Cre afforded no indications of tin-lodes or veins, and but slight evidence secondary silification, the quartz veins being mere threads.

"The absence of any specimens of stanniferous veinstones in the wa or of other than ordinary granitic detritus, favours the impression th the tinstone occurs leanly distributed in portions of the granite rat than in defined veins or lodes of secondary origin.

"Further prospecting is necessary to prove the locality, which, ow to the superficial character of the deposits, can be cheaply and exp tiously tested. So far, nothing of a payable nature has been discove and judging from the poverty of some of the channels through which enormous amount of material has been naturally ground-sluiced, prospects are not so hopeful as could be wished.

"An assay was made of a sample of the most promising looking gra from Portion 24, but no tin was detected."

Since then loose tin in unworn crystals has been reported from n Napoleon Reef, 2 miles from Locksley Railway Station, on the west fall of the Mount Lambie Range, but the discovery has not been confirme

Sheep Station Creek and Turon River.—Parish Sofala, County Roxbur —Tin ore was recorded from this locality in 1882.*

Stuart Town Division.

Spring Creek, Parish Burrandong, County Wellington.—Tin ore recor from this locality in 1882.†

Narrandera Division.

G. W. Card recorded tin ore in granite from near Narrandera.‡

* Liversidge, Min. Prod. N. S. Wales, 1882, p. 103. † *Op. cit.*, p. 103.
‡ Records Geol. Survey N. S. Wales, VIII, 1909, p. 275.

Carcoar Division.

Carcoar District.—In 1889 a sample of stream tin ore associated with ons, sapphires, magnetite, and a little gold, said to come from the rcoar District, was assayed in the Departmental Laboratory for a return of 6 per cent. of tin.

Molong Division.

Gumble, M.L. 7, Parish Manildra, County Ashburnham, about 4½ miles m Manildra Railway Station.

Tin ore was first recorded at Gumble in 1886 by C. S. Wilkinson.

'At Gumble, 12 miles south-east from Molong, Mr. J. E. Kelly, and ssrs. Delaney Bros. have done a considerable amount of work in opening ode which contains tin, copper, and silver, besides traces of gold and imony.

'The lode commences at the junction of granite and altered Silurian les, and traverses the latter for about 100 yards in a N. 30° E. ection. It varies in width from 1 to 8 feet, and consists of ferruginous pathic and siliceous lodestuff, more or less impregnated with green l blue carbonates, grey sulphide, and red oxide of copper, brown oxide tin, and magnetite. The tin ore principally occurs in the central and therly portions of the lode. The lode was opened in three places 60 to) feet in depth. . . . Seven average samples taken by myself across lode at different places yielded on assay at the rate of :—

Copper, from traces up to 2·85 per cent.
Tin, from traces to 0·50 per cent.
Silver from traces to 4 oz. 1½ dwts. per ton.
Gold—absent.

'A sample of the country serpentinous rock, showing native copper, ayed 4·2 per cent. of copper, with traces of tin and silver, and one ked sample of brown ore, showing tin oxide and carbonates of copper, n the lode at the 60 feet level, south drive, in the middle shaft, lded on assay: Copper, 3·85 per cent.; tin 58·70 per cent.; silver at rate of 8 oz. 19½ dwts. per ton. No gold.

'It is thus seen that the ores occur in patches, and not regularly seminated through the lode. The ores would, therefore, have to be ed. The tin oxide might, to a large extent, be separated by first shing the lodestuff and washing it in a buddle; but its complete aration by mechanical methods will be difficult; probably the con- sion of the copper ore into soluble sulphate of copper by a wet process uld be the most advantageous."*

'Further attempts to profitably work the lode proved unavailing, the large ixture of magnetic iron oxide proved misleading in estimating probable contents, and would also complicate mechanical concentration.

IX.—TIN DREDGING IN NEW SOUTH WALES.

dredging began in New South Wales in 1900 when the Cope's Creek prietary Dredging Company secured a large area of land along Cope's ek in the vicinity of Tingha. Mr. C. J. Lush was the pioneer in the rement.

trial plant of the suction type, with Kershaw pumps, was constructed. large area secured—300 acres—was subsequently divided up, and a ber of subsidiary companies formed, the order being the Wilberforce, per, Tingha, and Cope's Creek Central which absorbed the area.

* Ann. Rept. Dept. Mines for 1886, p. 132.

The first two were afterwards merged into the "Amalgamated Ti Dredging Company."

Under the general title of "dredging," by common usage, are include both bucket and suction plants, whether the latter be stationary, or on moveable barge or pontoon.

Suction pump methods are more correctly hydraulic sluicing where force steam pressure takes the place of natural gravity force.

The suitability and efficiency of the bucket or suction plant is determine by the nature of the ground to be operated on. Rough, uneven bottom with joints, cleavages, or other crevices, serving as natural riffles for th metallic or heavy ore particles, are best attacked by the powerful nozzl or "Monitors" of the suction method.

Soft, rotten bottoms, on the other hand, may perhaps, be more economicall worked by the bucket type.

At first a strong prejudice existed against dredging for gold and ti because of the contemplated pollution of the water channels, and damage alluvial flats. Particularly was the feeling entertained in connection wi dredging leases for gold on private lands. It was feared that virgin alluvi flats would—possibly for generations—be destroyed, and heaps of shingle le to mark the line of devastation. If carried to extremes the temporary gain gold would never compensate for destruction of perennial sources of agricu tural wealth. However, experience has proved that rarely more than t channel drifts, and limited areas of the banks in gold country, pay to p through; hence the broad cultivable flats adjoining are not interfered wit Moreover, most of the dredgable reaches of gold-bearing streams lie in rugg portions of the stream course unsuitable for agriculture.

In connection with tin dredging no trouble has arisen as regards alluvi flats, though complaints have been made as to water pollution; for where t best results have been obtained, rock outcrops and the natural inferiority the soils fronting the streams, such as Cope's and Vegetable Creeks, a sufficient barriers to cultivation.

As regards old-worked alluvial leads, both gold and tin, dredging inste of aggravating the evil, actually reclaims absolutely useless areas. Inste of a maze of potholes and shafts dangerous to children and stock, ba areas of bed rock, and tailing heaps, dredging dams tend to level flats, ev if at different elevations. The sludge, moreover, covers the surface with fine layer of productive silt. Emmaville is an example of the reclamatic

It is imperative, however, where pollution of running streams is liable damage water supply in settled country, that filter dams be provided befo discharging the spent water.

(*a*).—Tingha District.

Dredges and Dredging Companies, including ordinary Hydraulic Sluicing

Albion Flat Dredge.—In November, 1909, the Melbourne Cope's Cre Tin-sluicing Company (N.L.), removed their No. 2 plant from Star Gu and installed it at the lower end of Albion Flat, about 3 miles abo their Cope–Hardinge dredging site, in Parishes Cope's Creek and Swinto County Hardinge. The company secured about 88 acres by purchase, a 70 acres adjoining by lease.

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Amalgamated Tin-dredging Company's No. 2 Plant, Cope's Creek.

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[illegible] Plant, Cone's Creek

Before the close of the year, the plant, working one shift, treated 1,890 cubic yards for 1 ton 4 cwt. 1 qr. 25 lb. of tin ore, an average of 1·450 lb. per cubic yard. The cost averaged 10·88d. per cubic yard, and the rate of treatment 25 cubic yards per hour. The stony nature of the wash increased the cost, but better results are anticipated higher up Cope's Creek, where the wash is reported less stony.

Tingha–Inverell Mining Division.

Amalgamated Tin-dredging Company (N.L.). (Embracing the original Wilberforce and New Cooper Dredging Companies.)—G. S. Buzacott, secretary, Union Chambers, 70 Pitt-street, Sydney.

Three plants operating under the above company from January, 1907.

No. 1 Dredge, "Cooper Dredge," in G.L. 9, Parish Darby, County Hardinge, on Cope's Creek, near Tingha.

Plant.—One 10-inch gravel pump; one 10-inch nozzle pump. Two boilers, each 60 h.-p. Two Marshall engines, each 56 h.-p. Electric light plant, operated by 5 h.-p. engine, working a dynamo supplying three arc and thirty incandescent lights.

The nozzle pump is reported to be capable of discharging 2,000 gallons per minute.

Average fuel consumption, 35 cords per week (box, red gum, and stringybark) when working 22-feet ground.

Barge, 38 feet x 36 feet; depth, 4 feet 6 inches.

Boxes.—Length, 120 feet; width, 7 feet; depth, 2 ft. Fall, ½ inch per foot.

Capacity of plant, 80 cubic yards of material per hour; but only run to 40 or 50, to prevent undue loss of tin. Three shifts worked with total crew of twenty-four hands. Approximate width of channel, 6 chains.

Sections of material operated on in 1909 :—

Surface.
7 feet—Light yellow sandy drift; no tin.
8 ,, Coarse grey sandy drift; very slight amount of fine tin.
8 ,, Grey stony washdirt; fairly rich.

23 feet.

Average yield of all material, 1½ lb. tin ore per cubic yard. Tinstone reddish-brown, fine-grained, easily cleaned to high grade in Willoughby machine.

The Wilberforce Dredging Company (N.L.), was the second to start on Cope's Creek, having secured part of the Cope's Creek Proprietary Company's area. Operations began on the 17th September, 1902, with a small suction-pump dredge, but were hampered by want of water. The ground was reported to average 2 lb. of 73 per cent. tin ore per cubic yard.

There is no record of 1903 operations, but in 1904 35,000 cubic yards were treated for 32 tons 3 cwt. of tin ore, and 90 tons were obtained in 1905.

The directors' report at the annual general meeting on the 20th February, 1906, records the total output to date as 96½ tons, £1,950 being paid in dividends on preference and ordinary shares.

The company this year amalgamated with the New Cooper Dredging Company (N.L.).

The recorded output of the latter company in 1904 was 52½ tons of tin ore from 85,000 cubic yards of material sluiced, and 83 tons for 1905.

No. 2 *Dredge.*—G.L. 6, Parish Darby, County Hardinge. In village of Tingha. Working near Cope's Creek Bridge in 1909.

Plant.—One 10-inch nozzle pump; one 10-inch gravel pump; two boilers, each 25 h.-p.; electric light plant.

Three shifts worked.

Width of channel, about 2 chains.

Section :—

12 feet loose grey drift sand, carrying a very little tin in lower half.
2 feet 6 inches very coarse stony wash, carrying medium-grained tin. No clay.
Uneven granite bottom, with boulders.

No. 3 *Dredge.*—In M.L. 19, Parish Darby, County Hardinge, ¾ mile S.W of Tingha.

Plant.—Portable engine; gravel and nozzle pumps, for working shallow alluvial, cost £1,579.

Operations began August, 1906, continued for six months. Surfacing about 3 feet in depth, carrying a little tin throughout, but richest on the surface. Most obtained from west side of a north and south tin-reef running across the area; very little from east side. Total tin won, 7 tons.

Average yield, 1½ lb. per cubic yard; mostly angular ruby tin. Bottom, soft granite.

No. 4 *Reform Dredge.*—In Chain of Ponds, or Irwin's Gully, falling from the Brickwood Lead. Parish Swinton, County Hardinge.

Installed towards end of 1909, on site previously operated by a smaller plant (Bowden's).

Plant.—Similar to the Company's No. 1 Plant, already described.

Section of working face :—

12 feet red basaltic clay (pug).
4 feet red clay and sand, with a little fine tin.
4 feet stony wash-dirt, with tin.

Width, 4 to 6 chains. Bottom, decomposed granite; even; no boulders.

The stiff clayey nature of the overburden, and insufficiency of water, rendered operations very difficult, and led to abandonment.

Average yield, about 1¾ lb. per cubic yard.

Extracts from Yearly Reports.

Year ending 30th April, 1907 :—

	tons	cwt.	qr.	lb.		Net Return. £	s.	d.
Yield—No. 1 Plant	92	9	3	0	=	11,418	0	0
No. 2 „	73	1	1	0	=	9,034	0	0
No. 3 „	15	13	0	0	=	1,945	0	0
	181	4	0	0	=	£22,397	0	0

Year ending 30th April, 1908 :—

Yield—No. 1 Plant... ...	82	2	3	14	=	8,129	16	3
No. 2 „	61	10	1	22	=	5,731	1	9
No. 3 „	7	19	2	27	=	921	0	9
	151	13	0	7	=	£14,781	18	9

Dividends paid—Five of £1,500 = £7,500, to 30th April, 1908.

Average price obtained.—1906–7 = £123 12s. per ton; 1907–8 = £97 9s. 6d. per ton.

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Amalgamated Tin-dredging Company's Reform Plant, Cope's Creek.

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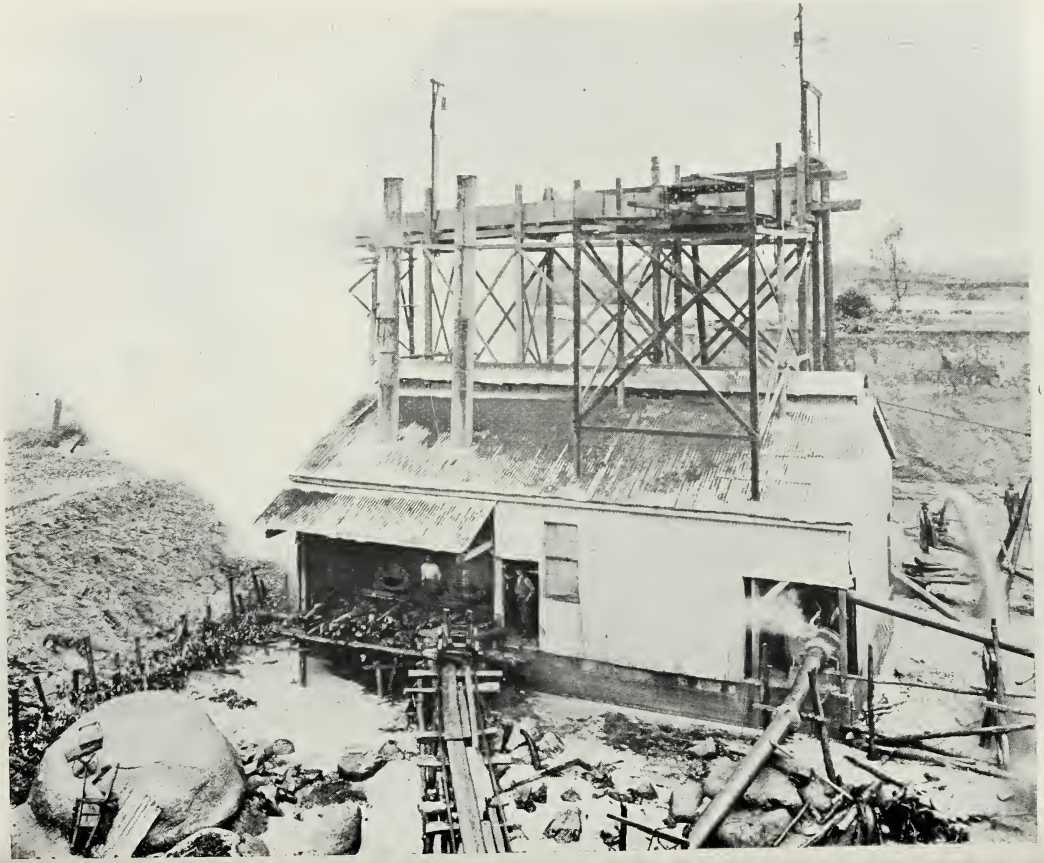

Blue Bell Dredge, near Smith's Garden, 1 mile south-east of Tingha, on Darby's Branch, Parish Cope's Creek, County Hardinge.

Operations commenced, by Messrs. Faulkner and Cox, about 1907, and continued for about two and a half years, when the dredge was removed to its present site on Long Hole Flat.

The ground worked varied from 10 to 20 feet in depth, and the wash was rich in patches, yielding up to 1 cwt. to the load of coarse reddish tin ore. No tin occurred in the overburden.

The alluvium treated at this site consisted of—

5 to 6 feet fine grey creek sand.

2 to 3 feet bluish clay.

1 to 2 feet bluish-grey drift sand.

2 to 3 feet fine water-worn wash.

Blue Bell Dredge, on Long Hole Flat, right bank of Herding Yard Creek, ¼ mile N.W. of Tingha, near Tingha–Inverell road. Parish Swinton, County Hardinge. Messrs. Faulkner and Cox, proprietors.

This plant is typical of a number of small plants that are becoming a feature of the mining operations in the Tingha district, which are intended for working over the tailings dumps of the large dredging plants, and the numerous small blocks of ground which have, for various reasons, been left by the latter.

This particular plant consists of a 4-inch nozzle-pump and an 8-inch gravel pump, operated by a 9 h.p. and a 14 h.p. portable engine. The material treated in 1909 at Long Hole Flat was poor, averaging only about ¾ lb. of fine tin ore per cubic yard. Operations, moreover, were hampered by the hardness of the overburden, and insufficient water supply, explosives being frequently necessary. The water difficulty was due to the plant having to operate several feet above the creek bed.

The original deposits of Long Hole Flat are reported to have been extremely rich, and were blocked out under the overburden, which was good "standing" ground. This doubtless accounts for the poverty of the remainder.

Following is a section of the present face :—

1 foot granite sand and soil.

1 foot yellow clay.

8 feet hard yellow sandy drift, with a little tin.

6 inches to 1 foot coarse angular wash, with tin.

Granite bedrock, uneven, but free of boulders.

Borah Creek Dredge.—Started operations in April, 1906. Treated 6,000 cubic yards of drift for 2·6 tons of tin.*

Bowden's Dredge.—Operating M.Ls. 35, 37, 39, Parish Herbert, County Gough. Middle Creek, 1¾ mile from Stannifer, above junction of Topper's Gully.

Erected by H. Bowden in 1908, worked for six months.

Plant.—Two portable engines, nozzle and gravel pumps, working up-stream.

Overburden, 1 to 10 feet of easily-treated sandy drift, carrying a little fine tin. Wash-dirt averages 1 foot in thickness.

* Ann. Rept. Dept. Mines for 1906, p. 27.

Bowden Syndicate (H. C. Bowden, Manager), Tingha. In Cope's Creek, immediately up-stream from the Tingha–Inverell road bridge, on that part of Tingha known as Hong Kong; Parish Darby, County Hardinge.

Operations commenced in May, 1910.

Plant consists of two portable engines, 16 and 14 h.-p. respectively; 8-in. gravel pump, and 9-in. nozzle pump. Average depth of alluvial, 19 feet, consisting mainly of drift sand. The bottom is of granite—hard and uneven on the west side, but soft and very even over the remainder. Black tin with some ruby tin, accompanied by a moderate quantity of black sand, occur in the wash. About $\frac{1}{2}$ acre was dredged to end of December, 1910, a large proportion of which has been virgin ground. Yield, 28 tons of tin ore to date. A grizzly was erected to cope with the rather large quantity of stone encountered through the alluvial.

Brimbo Dredge, $\frac{3}{4}$ mile S.W. of Tingha, on left bank of Cope's Creek, Parish Darby, County Hardinge. The stanniferous deposits consist partly of alluvial, and partly of shallow surfacing on granite. A gully runs through the centre into Cope's Creek in a northerly direction. Fairly rich tin was found in the original wash and soil, but little now remains. The depth varied from 2 to 10 feet away from the creek; where the gully enters Cope's Creek the depth reached 30 feet or more.

The Brimbo Dredge installed here consists of a 12-horse-power portable engine, nozzle, and gravel pumps, &c. First operated by Messrs. Wilberforce and Cox about 1906, who extended operations in a westerly direction for about a year. The ground treated consisted of clay, sand, and hard sandy drift with some clay, and varied in thickness from 16 to 30 feet. Fairly good yields of fine water-worn ore tin are stated to have been obtained. Operations, however, ceased on the death of Wilberforce, and the plant was sold to the Brimbo Dredging Company, which continued dredging at the same site for about six months, when the plant was again sold, and the Marcia Dredging Company entered into possession.

Clive Dredging Company.—In M.Ls. 607–611, Parish Clive, County Gough, about 2 miles east of Gilgai, on Pond's Creek.

Operations began in January, 1906, and were continued for about eighteen months.

Average depth of ground, 10 feet, consisting of creek sand.

The wash was partially cemented, especially on the right bank of the creek, and consisted partly of fine water-worn, and partly of coarse angular, material.

The tin ore was mostly fine water-worn ruby tin. An area of 600 yards by 44 yards was worked. The wash varied from 2 inches up to 2 feet in thickness, averaging 5 inches. The bottom consisted of both hard and soft granite, with numerous water-worn boulders. A little tin ore occurred throughout the overburden; the whole ground averaged 1 lb. per cubic yard. From M.L. 611, 11 tons were won, and 20 from M.L. 607, according to report.

Clive Tin-dredging Company.—W. M. Goodwin, Legal Manager, Inverell.

Started operations 1st August, 1904, in Portions 58, 59, 88, Parish Clive, County Gough, Pond's Creek, $2\frac{1}{2}$ miles east of Gilgai; and continued for about eighteen months, up-stream.

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The overburden consisted of granite sand with a little clay, overlying about 6 inches of coarse angular washdirt, with numerous large waterworn granite boulders. Bottom—granite, hard and uneven. An area of about 40 chains by 1½ chains was worked, abandoned finally owing to the tin giving out on very shallow ground.

The plant consisted of a barge carrying two marine engines, boilers, and 10-inch gravel and nozzle pumps.

The output in 1904 was 26 tons 15 cwt.*

The output in 1906 was 31 tons 14 cwt. 2 qr. 12 lb. of tin ore.† It is estimated that between 58 and 59 tons were extracted by the Company.†

Plant subsequently removed to Joe's Gully, Stannifer, M.L. 10, Parish Herbert, in August, 1907. Worked three months for a return of 19 tons 16 cwt. 3 qr. 7 lb. of tin concentrates.

Cope's Creek Dredging Company (N.L.).—R.V. Saddington, Legal Manager, Yaralla-chambers, 109 Pitt-street, Sydney. Capital, £18,000. Operating in Cope's Creek at junction of Murray's water, Parish Darby, County Hardinge, 2½ miles S.W. of Tingha.

This was the first tin dredging company to start in New South Wales.

According to the first report of the company, dated 30th September, 1900, a contract was let to W. Kershaw, Castlemaine, Victoria, for the supply and installation of dredging plant, including a pair of his patent gravel and hydraulicing pumps of 12 and 14 inches respectively, which are now supplied by Thompson and Co., engineers, Castlemaine.

This plant was successfully tried on the 4th February, 1901, and taken over on the 4th March. Owing to increased cost of plant, the capital was increased by £2,000 by issue of preference shares at 10s. each.

The present barge is 52 feet x 48 feet x 5 feet. The two boilers are each 70-horse-power, and engines of like capacity.

The 14-inch nozzle and 12-inch gravel pumps are on the same shaft. Nozzle power, 30 lb. per square inch. Electric light plant supplies, 4 arc and 16 incandescent lights.

About 1½ miles of the creek bed have been worked over since operations started. About 60 cubic yards per hour are treated where the ground is easily broken. The creek bottom is uneven; several deep holes occurred; waterworn boulders are plentifully strewn over it, but rich patches have occasionally been found under them. The working face during the latter part of 1909 was about 3½ chains wide, and presented the following section:—

1 ft. fine loose white creek sand.

4 ft. black clay, easily treated.

2 ft. creek débris—logs, roots, &c.

2 to 3 ft. loose grey drift, with a little fine tin ore.

1½ to 3 ft. coarse angular wash dirt, with tin ore; fairly rich, especially under boulders.

Granite bedrock.

Sluicing commenced 4th March, 1901.

* Ann. Rept., Dept. Mines, 1904, p. 29. † *Inverell Argus*, 5th February, 1907.

Cope's Creek Dredging Company (N.L.).

The following table, compiled from the Company's half-yearly reports, shows the results of operations to date :—

Period.	Material treated.	Tin ore obtained.				Yield, per cubic yd.	Dividends.	Remarks.
	cubic yards.	tons	cwt.	qr.	lb.	lb.	£	
I. Ending 30 Sept , 1900...	.....	.....				.....	.....	Contract let for plant. Firewood stacked at 7s. per cord.
2. ,, 31 March, 1901...	.....	5	7	0	0	1·16	.....	Plant taken over 4th March. Dry season. Unable to run full capacity. Paddock 16 feet deep. Old ground.
3. ,, 30 Sept , 1901..	.....	28	10	0	0	.....	.....	Water supply deficient until August ; then floods. Work hampered. Yield not up to estimate. Second paddock not cleaned up.
4. ,, 31 March, 1902...	.....	24	0	0	0	.....	.. . ...	Boulders caused trouble and delay ; necessitated wheeling of wash in some places. Water supply for boilers—bad.
5. ,, 30 Sept., 1902...	.....	35	14	1	1	.....	....	Injury to machinery caused delay from 6th August to 2nd October.
6. ,, 31 March, 1903...	128,000 (yielded 60 tons)	89	0	0	0	1·66	2,000	Work ceased for seven weeks through failure of water supply. New boxes erected. Preference shares paid off.
7. ,, 30 Sept., 1903...	.....	76	0	0	0	.....	2,700	Idle for thirteen weeks, owing to floods. 14 h-p. portable engine and 10-inch centrifugal pump purchased.
8. ,, 31 March, 1904...	.....	60	0	0	0	.....	.....	Sluicing began 9th November, after remedying flood damage. Under amended Gold and Mineral Dredging Act, 1902, rent reduced to 2s. 6d. per acre, with 1 per cent. royalty on gross value of tin ore obtained.
9. ,, 30 Sept., 1904...	.. ..	39	10	0	0	.....	.....	Ground rough and bouldery. Loss of £530 1s. 8d. on operations during period.
10. ,, 31 March, 1905...	.....	81	17	0	0	.....	1,800	....
11. ,, 30 Sept., 1905...	.....	67	10	0	0	.....	1,800	.. ..
12. ,, 31 March, 1906...	.....	50	10	0	0	.....	1,800	Twenty-eight days lost shifting plant. Ground narrow and bouldery.
13. ,, 30 Sept., 1906...	.....	46	15	0	0	.....	1,800	....
14. ,, 31 March, 1907...	....	48	15	0	0	.....	1,800	Dam burst, submerging plant. New barge built.
15. ,, 30 Sept., 1907...	.....	59	0	0	0	.....	1,800	Sluicing resumed in April. New sluice boxes. High-

	Period.	Material treated.	Tin ore obtained.				Yield, per cubic yd.	Dividends.	Remarks.
			tons	cwt	qr.	lb.		£	
16.	Ending 31 March, 1908...	....	84	0	0	0	.....	900	....
17.	,, 30 Sept., 1908...	.....	35	0	0	0	.....	900	Ground poor and shallow.
18.	,, 31 March, 1909...	....	45	0	0	0	.....	.....	Ground improving in value.
19.	,, 30 Sept., 1909..	....	77	0	0	0	.....	1,800	Payment to shareholders to date, 10s. per share on each share of 10s.
20.	,, 31 March, 1910...	....	66	0	0	0	.....	2,700	Principally won from Murray's Water Lease.
21.	,, 30 Sept., 1910...	.....	52	0	0	0	.....	900	Additional ground secured. Working poorer ground back to Cope's Creek.
22.	,, 31 Dec., 1910 ...	.. ..	18	14	3	3	.....	.....	Interim return supplied by Legal Managers.
	Totals	.....	1090	3	0	4	.....	£22,700	

Cope's Creek Central Tin-dredging Company (N.L.).—T. Rollason, Legal Manager, 31 Queen-street, Melbourne. Capital £7,500, in 30,000 shares of 5s. each.

Working the bed of Cope's Creek, at Wright Town, 3½ miles west-north-west of Tingha, in G.Ls. 8 and 20, and M.Ls. 12 and 17, Parishes Swinton and Darby, County Hardinge.

Plant.—Two engines of 150 indicated horse-power each, with boilers of similar capacity; 12 inch nozzle and gravel pumps. Pontoon or barge 45 feet x 40 feet x 5 feet. Total weight with machinery approximately 200 tons. Floats in 3 ft. 9 in. of water. Sluice boxes 150 feet long, 12 feet wide, and 3 feet deep. Grade half an inch per foot. When on bottom the gravel pump elevates material 70 feet to boxes. Rate of dredging 70 to 80 cubic yards per hour, mostly old worked ground and creek sand.

The bed of the channel is uneven and interrupted by hard granite bars, aggravated also by numerous large boulders. About 25 acres dredged in three and a half years. Face towards end of 1909 exposed for a width of 3 chains, and exhibiting the following section :—

15 feet yellow sandy loam—mostly creek material.
2 feet grey stony wash-dirt.
Bottom—slates and granite.

Sluicing began 2nd January, 1906.

Cope's Creek Central Tin-dredging Company (N.L.). (Table compiled from Company's Reports.)

Period.	Material treated.	Tin ore obtained.				Yield per cubic yard.	Dividends.	Remarks.
	cubic yards.	tons	cwt.	qr.	lb.	lb.		
1.	.....	.....				.....	.....	Barge site excavated north end of M.L. 17; depth 8 feet inflow of water prevented bottoming. Plant supplied by Messrs. Thompson & Co., Castlemaine. M.L. 315—purchased.
2. Ending 30 Nov., 1905	.....	.....				.....	.....	
3. ,, 31 May, 1906 ...	77,100	28	12	1	5	0·83		Plant taken over 13th January; cost = £3,002 19s. Started in poor ground. Cost per cubic yard = 8.98d. 44·6 cubic yards sluiced per hour of working time. Tin ore sold locally at £110 12s. 3d. per ton.
4. ,, 30 Nov., 1906 ...	126,400	81	4	3	11	1·43	.....	Cost of working, 7·01d. per cubic yard; 53 cubic yards sluiced per working hour; heavy floods destroyed dams.
5. ,, 31 May, 1907 ...	112,000	83	15	0	0	1·67	Nos. 1 & 2, £2,000.	Cost of working, 8·32d. per cubic yard; 50 cubic yards sluiced per working hour; ground shallow, with hard bottom; extended suctions used; Tet Fong's M.L. 315—purchased for £1,000—realised a net profit of £5,737 to date.
6. ,, 30 Nov,, 1907 ...	114,200	62	6	0	0	.....	No. 3, £1,000.	Cost, 8·7d. per cubic yard; plant treated 46·8 cubic yards per working hour; additional plant, 12 h.-p. portable engine and 10-inch centrifugal pump.
7. ,, 31 May, 1908 ...	116,000	68	13	2	0	1·33	No. 4, £750.	Cost, 7·7d. per cubic yard; treated 56·2d cubic yards per working hour; tin cost £56·64 to produce to 75 per cent. grade; plant being dismantled prior to removal to a new site in G.L. 8,
8. ,, 30 Nov,, 1998 ...	.....	33	7	3	19	.....	.....	Sluicing in new site began 1st October; ground narrow—extended suction pipes necessary.
9. ,, 31 May, 1909 ...	120,000	61	14	3	20	1·15	.....	Cost of treatment, 7·94d. per cubic yard; rate of sluicing, 51 cubic yards per hour.
10. ,, 30 Nov., 1909 ...	120,000	78	3	3	17	1·46	Nos. 5 & 6, £1,500.	Cost of treatment, 7·58d. per cubic yard. Dams and protection works carried away by floods.
11. ,, 31 May, 1910 ...	92,300	48	13	2	3	1·18	Nos. 7 & 8, £1,500.	Cost of treatment, 8·8d. per cubic yard; rate of sluicing, 59·7 cubic yards per hour. Floods caused loss of time and damage.
12. ,, 30 Nov., 1910 ...	190,700	105	12	1	14	1·24	Nos. 9–14, £4,500.	Cost, 5·36d. per cubic yard; rate of sluicing, 75·3 cubic yards per hour.
13. ,, 31 Dec., 1910 ...	.....	12	1	2	5	.....	.....	(Supplied by Legal Manager).

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Cope's Creek Central Tin-dredging Company's Plant, Cope's Creek.

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Elsmore Hill Sluicing Operations.

Cope's Creek Extended Tin-dredging Company (See Tingha Consolidated.)
Cope-Hardinge Dredge (See Melbourne-Cope's Creek).

Costello's Dredge, Joe's Gully, M.L. 10, Parish Herbert, County Gough, near junction with Middle Creek, about 1 mile south of Stannifer.

Site originally worked for a short period by the Clive Dredging Company, and abandoned.

Messrs. T. and P. Costello in 1909 installed a small plant, consisting of a portable engine, and small nozzle and gravel pumps. The overburden ranges from 12 to 14 feet, with very patchy wash-dirt underlying, up to 2 feet in thickness, mostly coarse and angular. The bedrock is granite, fairly soft for the most part, but uneven and strewn with numerous boulders. No tin is obtained from the overburden. Operations are being carried on downstream in centre of channel, but have been hampered by water scarcity.

Six tons of ore obtained during 1910.

Darby's Branch Tin-dredging Company (*N.L.*).—On Darby's Branch at junction of Red Hill Gully, M.L. 45, Parish Cope's Creek, County Hardinge.

Plant.—Horizontal Robey engine of 20 horse-power and a locomotive boiler of 40 horse-power, with 8-inch gravel and 4-inch nozzle Wilberforce pumps. Operations began about end of 1908.

The ground averages about 14 feet in depth.

Section ...
- 6 feet white sand.
- 2 ,, black sand.
- 4 ,, grey sand.
- 1 to 2 feet washdirt, consisting of quartz and granite fragments, yielding about 2 lb. of coarse, angular tin ore per load.
- Granite bedrock.

Fourteen tons of tin-ore obtained in 1909, and 28 in 1910.

Elsmore Tin Sluicing Company (*N.L.*), James Mackay, Legal Manager, 125 Queen-street, Melbourne. Paid-up Capital, 24,000 shares of 10s. each.

Elsmore Hill, Parish Anderson, County Gough. Site of first payable tin discovery in New South Wales. Worked originally by ground sluicing by the Elsmore Tin Mining Company, afterwards by the Union Tin Mining Company, and tributors.

Soon after application of hydraulic sluicing and dredging, after the modern system, to tin-mining in the State, Messrs. Brown Brothers, Cooper, and Company secured the site, and installed a plant for working the ground, with hydraulic nozzles supplied by powerful pumps. The force-pumps, however, set up on the river bank were unable to elevate the water to the full height required to command the top of the hill, viz., 240 feet. Their interests were then disposed of to a larger company, the present Elsmore Tin Sluicing Company, in August, 1905, which began operations in February, 1906.

The progress of the latter will be seen in the accompanying table prepared from the half yearly reports.

Elsmore Hill, or that portion of it forming the scene of tin-sluicing operations, is cone-shaped, the natural fall thus enabling the surfacing to be ground sluiced by nozzle pressure; the advantage thus secured enabled the water to be re-used at lower levels by a second pumping plant.

The storage reservoir excavated on the apex of the hill was supplied from the Macintyre River by two Auldjoe's patent constant flow pumps of 135 horse-power, set at a distance of 28½ chains, and 240 feet depression.

In working with the nozzles on the higher parts of the hill, boxes were only utilised at intervals, the material being sluiced into ground channels, Sand's gravel and nozzle pumps, and one Tangye pump being employed as the work progressed. About 45 acres were sluiced during the first five years, only the shallower ground being worked. The deeper, 10 to 40 feet, is now being attacked, a new Fairbank-Morse compound duplex steam pump being installed at the river, to secure an adequate water supply for the heavier ground.

The hill being intersected with small stanniferous veins of quartz, bearing frequent vughs invested with beautifully crystallised smoky quartz and cassiterite, the concentrated tin ore in the boxes and sluices was largely composed of unworn crystals, the resplendent lustre of many of the crystal aggregates being unsurpassed. It is only as the tin ore is followed away from its source that attrition is marked.

The veins and the enclosing country also contain nests of wolfram, a little bismuth, molybdenite, and scheelite, the first being the most common.

ELSMORE Tin Sluicing Company.

(Table prepared from Company's Reports.)

Period.	Material treated.	Tin ore obtained.	Yield per cubic yard.	Dividends paid.	Remarks.
	cubic yards.		lb.		
1. Ending 31 Dec., 1905 ...	10,450	15 tons (approximate).	3·21	.. ...	Mine taken over 8th August, 1905; sluicing started 16th August; ran one shift to 13th September; restarted 27th September; worked continuously to 12th November; recommenced 14th November, and continued to 31st December.
2. ,, 30 June, 1906 ...	7,238 opening out with new plant.	tons. cwt. qr. lb. 9 10 0 15 3 11 2 17	2·94	.....	Obtained with small portable plant running irregularly between January and 21st April, owing to shortness of water; last clean up 12th May; plant then idle; new portable plant erected with 20-h.p. engine for gravel-pump; 16-h.p. for nozzle-pump; boxes 120 in. x 6 in. erected; started sluicing 19th April; progress slow opening out; water supply deficient; new pumping plant erected on river.
3. ,, 31 Dec., ,, ...	40,060 purchased from tributors.	37 18 3 26 8 18 2 1	2·12	.....	No. 1 plant ran 1,900 hours, treating 24,760 cubic yards; ground averaged 5 to 21 feet in depth; explosives used in part; plant removed to new site; No. 2 plant worked intermittently, owing to accident to pump.

ELSMORE Tin Sluicing Company.—*continued.*

Period.	Material treated.	Tin-ore obtained.	Yield per cubic yard.	Dividends paid.	Remarks.
	cubic yards.	tons. cwt. qr. lb.	lb.		
4. Ending 30 June, 1907 ...	41,351 purchased.	53 3 0 19 6 13 3 5	2·75 to 3·06	.....	No. 1 plant worked 2,096 hours for 21,726 cubic yards; yield $2\frac{3}{4}$ lb. per cubic yard; ground 3 inches to 18 inches; No. 2 plant worked 2,104 hours for 19,625 cubic yards; yield $3\frac{1}{16}$ lb. per cubic yard; electric lighting plant installed.
				£	
5. ,, 31 Dec., ,, ...	45,981	54 19 1 11	2·62	600	Working two shifts with both plants; ground surfacing 12 inches to 18 inches deep.
6. ,, 30 June, 1908 ...	4,647	5 6 3 21	2·75 to 2·62	.....	Mine closed from 1st January to 11th May; restarted one shaft only; ground mostly stony; No. 1 plant started 15th May; No. 2 plant on 9th June.
7. ,, 31 Dec.. ,, ...	21,732	25 14 3 4	2·37 to 3·17	.....	Working each plant one shift for greater part of period; surfacing 12 inches to 24 inches; hard ground passed over by previous workers; decided to discontinue shallow ground and attack deeper; river pump thrown out of use; large Tangye pump supplied water to nozzle dams.
8. ,, 30 June, 1909 ...	19,667	22 8 2 18	2·55	.....	No surfacing sluiced; work confined to deep ground, varying up to 20 feet; large quantity of explosives necessary; average rate 11 cubic yards per hour; cost 1s. $8\frac{1}{2}$d. per cubic yard.
9. ,, 31 Dec., ,, ...	35,800	30 3 2 3	1·88	.....	Depth of ground varied from 10 to 18 feet; explosives necessary; rate—24 cubic yards per hour; cost 12·8d. per cubic yard (including all charges and cartage to Inverell).
10. ,, 30 June, 1910 ...	46,805	32 7 2 13	1·55	.....	Depth of ground, 2 to 20 feet; rate, 28 cubic yards per hour; cost, 11·89d. per cubic yard; new pumping plant established on Macintyre River; portable sluicing plant being moved to new site near top of Elsmore Hill.
11. ,, 31 Dec., ,, ...	19,957	15 2 1 26	1·5 to 1·6	.....	No. 1 plant worked 784 hours at rate of 12 cubic yards per hour and a cost of 22·1d. per yard. No. 2 worked 681 hours at 16 yards per hour and a cost of 14·6d. per yard.
Totals	235,940	246 0 1 8	2·29 average	£600	

Ferris Tin Sluicing Company (*No-liability*), J. Mackay, Legal Manager, 125, Queen-street, Melbourne ; capital, 30,000 shares at 5s. ; Stannifer.

Operating in the old Stannifer alluvial diggings, near Middle Creek, on north side.

This field was opened in the early seventies, large quantities of stream tin being won from it. This particular dredging site was originally sold at different times for £6,000 and £12,000, and floated into companies, according to local information. The wash was then carted to Middle Creek, and box-sluiced. The width of the alluvial averaged 200 feet, and the wash varied up to 5 feet in thickness, the best portions yielded 1 cwt. to the load. Discovered by D. Lowe, J. Burlington, and Schumann.

Ferris Tin Sluicing Company, Stannifer.

Period.	Material treated.	Tin ore obtained.	Yield per cubic yard.	Dividend.	Remarks.
		tons cwt. qr. lb.	lb.		
1. Ending 31 Dec., 1906	2,928	5 4 0 16	3.87	.....	Took over charge 5th Novembe
2. ,, 30 June, 1907	.....	17 15 0 3	....	.....	Work commenced 3rd Januar plant removed to new sit sluicing resumed 27th Fe ruary.
3 ,, 31 Dec., ,, ...	22,787 from previous paddock.	14 3 2 14 6 5 3 8	....	.....	Ground hard ; explosives nec sary ; plant shifted 2 August ; resumed 2nd Se tember.

Frazer's Dredge.—M.L. 209, Parishes Clive and Herbert, County Gough ; 2½ miles below Stannifer, in Middle Creek.

Began sluicing May, 1908. Work intermittent. Plant, 20 h.-p. Blackstone oil engine, and Finch "Wilberforce" gravel pump. No nozzle used. Wash elevated to gravitation sluice boxes. Tailings run to dam a few feet above suction pump ; water gravitates back. Depth of creek drift, about 16 feet to granite bedrock. The bottom wash averages about 4 inches, and is coarse and stony.

Fraser obtained about 3 tons of tin ore for three months work up to 12th December, 1908.

The lease was subsequently taken on tribute by the Amalgamated Tin Dredging Company, when two portable engines, with nozzle and gravel pumps, were installed. Six tons of tin ore were obtained before the Company abandoned the site.

Inverell Dredging Company.—(See Clive Tin Dredging Company.)

Kershaw Dredge.—Murray's Water-sluicing Syndicate, ¼ mile above junction with Cope's Creek. Parish Darby, County Hardinge, 2¾ miles south-west of Tingha.

Plant.—Two portable engines, and Kershaw 12-inch and 10-inch nozzle and gravel pumps, &c. Started 11th October, 1906 ; obtained 4·2 tons ; 1907, obtained 21¼ tons.

Murray's Water alluvial and drift has a width of 8 to 10 chains, and an average depth of about 15 feet at the dredging site. The overburden consists of yellow sandy clay resting on about 2 feet of somewhat coarse angular wash carrying tin ore. The average tin yield is somewhat low.

Marcia Tin-dredging Company.—Left bank of Cope's Creek, ¾ mile south-west of Tingha, on Brimbo Surface. Parish Darby, County Hardinge.

Plant.—Two engines 16 and 12 h.-p., operating 8-inch Morris nozzle pump, and 8-inch Sands gravel pump. Operations commenced 15th August 1908, and continued to 9th January, 1909. A typical section shows the following strata:—

15 to 18 feet, hard cemented sandy drift with some yellow clay.
2 feet medium grade water-worn wash with fine tin.
Granite bedrock.

The hardness of the overburden rendered explosives necessary to break it down for the nozzles. The richer portion was confined to a gutter about 5 feet wide, which yielded at the rate of 3 lb. per cubic yard of fine water-worn reddish tin ore; on the higher ground it was coarse, angular, and black. The gutter gradually shallowed in an eastern direction and gave out on a high granite bar, when operations were discontinued. About 4 tons of tin ore were obtained.

Melbourne Cope's Creek Tin Sluicing Company, N. L., J. Mackay, Legal Manager, 125, Queen-street, Melbourne. Herding Yard Gully, M.Ls. 32, 62–65, 100, 107, 157, 405–408, 421, 424, 427, Parish Swinton, County Hardinge.

The Herding Yard Site was originally held by the Cope-Hardinge Dredging Company; subsequently sold and refloated under the present title, under which, on 18th July, 1906, operations recommenced.

Plant.—Two 120 h.-p. horizontal compound condensing engines, with two Dryback marine boilers, operating a 10-inch gravel pump and a 12-inch nozzle pump; condenser and electric-light plant, the whole installed on a barge.

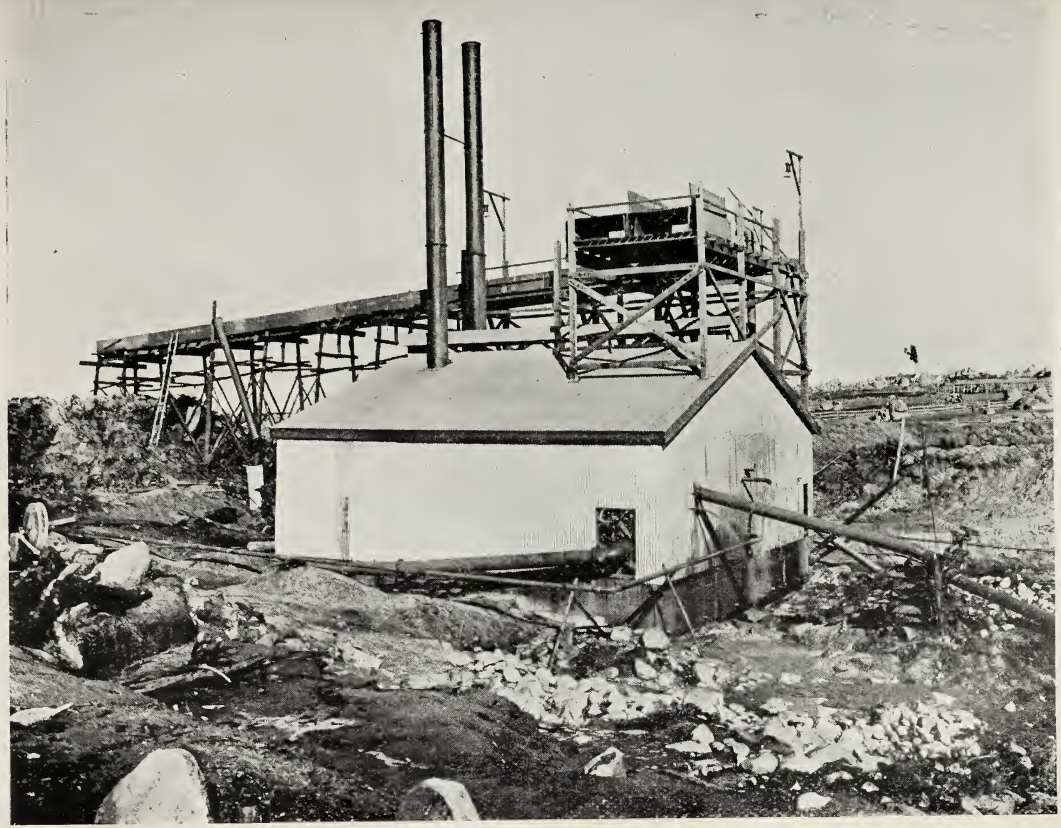
The present course of the stream is about 3 chains wide on the average, but the former stream was dammed back by the granite bar at the village of Tingha, producing fairly thick sheets of stiff clay.

During 1910 the upper end of the Herding Yard Gully site continued payable. Considerable difficulty attended each shift to a new paddock, owing to intervening granite bars, which somewhat shortened the actual sluicing time.

The Albion Flat site (No. 2 plant), about 3 miles up Cope's Creek from No. 1 plant, during 1910, was being opened at the lower end of Davis' block, off the main run of tin ground, so as to provide a new channel for the creek. This is expected to be completed about March, 1911, when the deeper tin-bearing ground on Davis' and Westerway's blocks—which gave very satisfactory prospects— will be worked.

From levels and shafts 15 or 20 chains ahead in Westerway's paddock, the bedrock was estimated to be 6 or 7 feet lower than at the present site, probably forming a catchment basin for the drift tin.

Period.	Material treated.	Tin obtained.	Yield per cubic yard.	Dividends and bonuses.	Remarks.
	cubic yards.	tons cwt. qr. lb.	lb.	£	
1. Ending 31 Dec., 1906 ..	55,438	61 10 0 9	.....	3,000	Result of run from 18th July to 19th December; amount equivalent to 31 per cent. of the called up capital returned in dividends during half year.
2. ,, 30 June, 1907 ...	95,331	83 7 3 9	1·959	3,750	4¾ acres worked during half year; barge shifted twice; sluicing averaged 34 cubic yards per hour; cost 8¼d. per cubic yard.
3. ,, 31 Dec., 1907...	73,775	54 1 2 7	1·656	3,000	Approximately 15 acres worked to date; rate of sluicing 26 cubic yards per hour; cost 10·28d. per cubic yard; area held 200 acres; other areas applied for in Star Gully.
4. ,, 30 June, 1908 ...	101,375 (No. 1 plant.)	66 3 2 25	1·463	.....	Rate of sluicing 32½ cubic yards per hour; cost 7·43d. per cubic yard; barge shifted three times; average value less owing to increased overburden.
4. ,, 30 June, 1908 ...	26,540 (No. 2 plant.)	13 10 0 0	1·136	.....	Rate 23 cubic yards per hour; cost 11·85d.; high owing to initial cost of opening up, and raising tailings out of creek; operating in Star Gully.
5. ,, 31 Dec., 1908 ...	112,830 (No. 1 plant.)	69 10 1	1·379	.....	Rate 37 cubic yards per hour; cost 7·23d. per cubic yard.
5. ,, 31 Dec., 1908 ...	19,348 (No. 2 plant.)	5 10 0 14	0·638	.....	Rate 29 cubic yards per hour; cost 8·83d. per cubic yard; plant removed to top end of lease; worked seventeen days then stopped owing to want of water.
6. ,, 30 June, 1909 ...	126,510 (No. 1 plant.)	82 10 2 10	1·461	1,500	Rate 42 cubic yards per hour; cost 7·18d. per cubic yard; overburden increased to maximum of 30 feet; barge floated to two new sites; boring operations carried out in Star Gully; option secured over 88 acres at Albion Flat; No. 2 plant idle owing to want of water.
7. ,, 31 Dec., 1909 ...	109,360 (No. 1 plant.)	64 5 2 20	1·317	1,500	Rate 43 cubic yards per hour; cost 7·02d. per cubic yard; returns unlikely to be so profitable during ensuing half year; plant to be removed to Albion Flat as soon as payable ground exhausted.
7. ,, 31 Dec., 1909 ...	1,890 (No. 2 plant.)	1 4 1 25	1·450		Rate 25 cubic yards per hour; cost 10·88d. per cubic yard; working Albion Flat; wash stony.
8. ,, 30 June, 1910 ...	82,250 (No. 1 plant.)	47 9 3 15	1·445	750	Rate 31 cubic yards per hour; cost 8·62d. per cubic yard; hard bars, bouldery wash, and narrowness; reduced output; plant removed four times.
8. ,, 30 June, 1910 ...	43,550 (No. 2 plant.)	25 13 2 3	1·321		Rate 20 cubic yards per hour; cost 12·7d. per cubic yard; shallowness of ground tended to increase cost; barge purchased for No. 2 plant.
9. ,, 31 Dec., 1910 ...	118,000 (Nos. 1 & 2 plants.)	62 1 3 11	1·469 ·451	750	No. 1 plant treated 82,550 cubic yards at a cost of 8·6d. per yard. No. 2 plant 35,450 (for three months) at a cost of
Totals	802,189	650 19 2 15	1·43	13,200	



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Melbourne Cope's Creek Tin Sluicing Company's Plant, Herding Yard Gully.

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Melvaine Bros'. Dredge.—On left bank of Sutherland's Water, adjoining south boundary of M.L. 76, Parish Darby, County Hardinge.

Plant.—14 h.p. portable engine, operating an 8-inch gravel-pump; the material being brought to the pump-hole by gravity sluice. Working up-stream. Operations commenced January 2nd, 1909, and sluicing on February 2nd. The face exposed the following section (width, 3 chains) :—

8 feet, yellow sand.
4 feet, stiff blue clay. } No tin.
1 foot, wash-dirt; very little stone.
Granite bedrock, even; no boulders. } 8 tons of tin ore obtained in 1910, and 9 in 1909.

Yield, about 1½ lb. of medium-grained water-worn tin-ore per cubic yard.

McIlveen's Dredge.—On right bank of Middle Creek, immediately below Tingha-Stannifer road crossing, adjoining north boundary of M.L. 218, Parish Herbert, County Gough.

Operations begun by Messrs. Smith and McIlveen in 1908, and continued for fifteen months. Plant consisted of one 18-h.p. and one 12-h.p. portable engines, nozzle and gravel pumps. Average depth of overburden, 7 to 8 feet, consisting mainly of loose creek sand drift. Bedrock mostly hard and uneven, with numerous boulders. The wash-dirt was coarse and angular, and more or less cemented. Average thickness, 1 foot. Approximately 10 tons of fine water-worn red and black tin-ore are reported to have been won.

Murray's Water Dredging Syndicate.—Murray's Water, Tingha. R. V. Saddington, Legal Manager, 109, Pitt-street, Sydney. (See Kershaw Dredge.)

In 1907 produced 22 tons 17 cwt. 2 qr. 0 lb. Did not work full time.*

Began operations 11th October, 1906.

New Cooper Dredging Company.—(*See* Amalgamated).

New England Tin Dredge and Pump Syndicate.—(*See* Tingha Consolidated).

Reform Tin-dredging Company.—W. M. Goodwin, Inverell, Legal Manager. Cope's Creek, Tingha.

1906.—Produced 89 tons 1 cwt. 1 qr. 16 lb. tin-ore.† 1907.—Produced 105 tons 9 cwt. 2 qr. 11 lb. tin-ore, from 162,000 cubic yards. ‡

Stannifer Tin-dredging Company.
Stannifer Central Tin-dredging Company. } *See* Tingha Consolidated.

Tet Tong's Dredge.—M.L. 345, Parish Swinton, County Hardinge, 1½ miles north-east of Tingha, on right side of Tingha—Guyra road.

Plant.—25-horse-power Hornsby oil engine, 8-inch Wilberforce gravel pump, gravitation sluice. Operations commenced in 1906, but continued for a few weeks only. Overburden difficult to treat, consisting mainly of basalt clay, and stone. A section of the face shows the following strata :—

15 feet, decomposed basalt.
4 feet, fine drift, with boulders.
6 inches, fine water-worn wash-dirt with much coarse black sand and fine water-worn tin-ore.
Soft granite bedrock, dipping east.

Average yield, about 25 lb. per load. About half a ton of tin ore won.

Thomas' Dredge.—On lower portion of Summerhill Creek in M.L. 27, Parish Cope's Creek, County Hardinge, 3¼ E.S.E. of Tingha.

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* *Inverell Argus*, January 31st, 1908. † *Inverell Argus*, February 7th, 1907.
‡ *Inverell Argus*, January 31st, 1908.

Operations commenced by A. Thomas at end of 1907, and continued for a few months. Overburden averaged 17 feet in thickness, and consisted mainly of granite sand with a little clay; on a very uneven bottom. The tin-ore was coarse and angular; only a small quantity obtained. Portable engine used. Prospecting plant only.

Tingha Consolidated Tin Mines, No Liability.—A. Pearson, Legal Manager, 34 Queen-street, Melbourne. Capital, 400,000 shares at 10s. per share.

Incorporated August, 1906, for the purpose of acquiring various dredging properties, which were taken over in November, 1906, viz., Cope's Creek Extended, New England Tin-Dredge and Pumping Syndicate, Stannifer Tin Dredging Company, Stannifer Central, Tingha South, and Tingha South No. 1 dredging plants.

The Company operates seven separate plants, which commenced work with Nos. 1, 2, 3, 4, November, 1906; Nos. 5 and 6, May and November, 1907.

No. 1 Plant, "Stannifer."—In M.L. 210, Parish Herbert, County Gough, Middle Creek, Stannifer; consists of barge with two large portable engines, 8-inch nozzle pump, and 10-inch gravel pump. Overburden averages 10 feet in thickness, consisting mainly of drift sand. The average thickness of wash-dirt being from 2 to 3 feet, carrying a little fine water-worn tin-ore. Bedrock fairly even, with occasional hard bars and granite boulders. The wash-dirt is mostly coarse and angular; practically no black sand with tin.

New England Tin-Dredge and Pump Syndicate.—Sutherland's Water, Tingha.

In 1906 obtained 11 tons 10 cwt. 0 qr. 15 lb. of tin-ore. Subsequently incorporated in Tingha Consolidated Tin Mines, Limited.

No. 2.—Stannifer Central Tin-dredging Company.

In 1906 obtained 9 tons 14 cwt. 2 qr. 18 lb. of tin-ore. Then incorporated under Tingha Consolidated Tin Mines, Limited.

Stannifer Tin-dredging Company.—Middle Creek, Stannifer.

In 1906 obtained 89 tons 1 cwt. 1 qr. 16 lb. of tin-ore. Incorporated under Tingha Consolidated Tin Mines, Limited.

No. 3 Plant.—S.G.L. application 3, Parish Darby, County Hardinge, on Sutherland's Water; consisting of barge, two portable engines—25-horse power, 10-inch gravel pump, 8-inch nozzle pump.

Overburden about 16 feet, showing the following section:—

4 feet, stiff grey clay.
2 feet, stiff blue clay.
8 to 10 feet, hard sandy drift, with a little tin.
3 to 4 feet, fine water-worn wash-dirt, carrying tin.
Granite bedrock.

Width of working face, 1½ to 2 chains. Tin-stone somewhat coarse, and of dark red and black colour.

No. 4 Plant, "Tingha South No. 1."—Sutherland's Water, G.L. 7, Parish Darby, County Hardinge. Barge, 40 feet by 25 feet by 4 feet 6 inches, two Robey portable engines—24 and 14 horse-power, gravel and nozzle pumps. Face 4 chains wide towards end of 1909, showing the following section:—

3 feet, cement, with frequently fine tin-ore.
12 to 15 feet, Loose grey drift, with occasional patches of clay; no tin.
1 to 1½ feet coarse angular stony wash-dirt.
Granite bedrock.

Since commencement of operations in 1906 the channel has been worked for about a mile.

The bedrock is somewhat irregular and strewn with large granite boulders. A yellow cement on the side of the gutter requires explosives to break it down. The "tightness" of the overburden is exemplified by blocking, and tunnels of thirty years ago, still intact, though unsupported by timbering. Exposure appears to harden rather than disintegrate.

No. 5 Plant, "Cope's Creek Extended."—In Cope's Creek, at Wright Town, 3 miles west of Tingha. Barge, engines, and 10-inch gravel and 8-inch nozzle pump.

Overburden, 18 to 30 feet, showed the following sections at the shallower end :—

4 feet. Stiff yellow clay.
3 feet. Cemented yellow clay.
2 feet. Fine-grained loose red sand.
4 feet. Stiff bluish clay.
1 foot. Fine red-drift, practically barren.
3 feet. Loose grey sand.
1 to 3 feet. Fine stony wash-dirt, with tin ore.
Granite bedrock.

The bedrock is somewhat uneven, and strewn with huge granite boulders. Working face towards end of 1909, about 5 chains wide. Occasional shooting necessary to break up overburden.

No. 6 Plant.—M.L. 24, Parish Darby, County Hardinge, on Sutherland's Water. Consists of two boilers each 50-horse power ; 10-inch gravel pump ; 8-inch nozzle pump. Working deep ground on right bank of stream. Face exposed at latter part of 1909 gave the following section :—

28 feet. Stiff yellow clay.
2 feet. Fine drift, with very little stone, carrying tin ore.
Granite bedrock.

No. 7 Plant.—In Cope's Creek, 3 miles west of Tingha, at Wright Town. This is probably the most up to date plant in operation on the field, costing £6,000. Barge, 45 feet x35 feet x 4 feet 6 inches, with two dryback marine boilers, each 125 horse-power indicated ; two compound surface condensing engines ; one of 90 horse-power operating 10-inch gravel pump ; and one of 125 horse-power operating 12-inch nozzle pump ; working pressure, 125 lb. per square inch. An independent air engine attached to surface condenser. Electric light plant.

Most of the overburden, consisting largely of highly cemented granite detritus and stiff clay, requires explosives.

Width of working face about 2 chains. Bedrock fairly even, partly strewn with large granite boulders, the richest patches being under or near the boulders as a rule, owing to the natural ripples caused by the obstruction.

The average depth to bedrock is about 18 feet, as follows :—

2 feet. Granite detritus, with yellow clay, cemented.
6 feet. Stiff reddish yellow clay.
2 feet. Loose grey sand.
1 foot 6 inches. Fine reddish wash-dirt, with a little fine tin ore.
2 feet. Loose grey sand.
2 to 6 feet. Medium grade wash-dirt, with fine reddish brown tin ore.
Granite Bedrock.

Tingha Consolidated Tin Mines (No-Liability).—Tingha District. Statement from Company's Half-yearly Reports.

Period.	Material treated.	Tin ore obtained.	Yield per cub. yard.	Dividends.	Cost per cub. yard.	Remarks.
	cub. yards.	tons. cwt. qr. lb.	lb.	£ s. d.	d.	
Half-year ending 31st Jan., 1907	80,266	51 12 0 0	1·44	... .	11·5	Costs include office and London charges; only four plants at work; new plant being erected at Stannifer Central; modern plant ordered for Cope's Creek Extended.
,, ,, 31st July, 1907	247,272	170 0 0 0	1,54	5,000 0 0	10·9	Dividends on preferential shares; new engine and boiler installed on Cope's Creek Extended plant; additional plant placed on Tingha South and South Extended.
, ,, 31st Jan., 1908	255,322	134 10 0 0	1·18	5,007 11 2	10·96	
,, ,, 31st July, 1908	.....	151 0 0 0	.....	.....	.....	No particulars given.
,, ,, 31st Jan., 1909	342,362	195 0 0 0	1·27	....	9·39	Three dredges submerged by floods.
,, ,, 31st July, 1909	309,407	186 10 0 0	1·35	.. ..	10·63	
,, ,, 31st Jan., 1910	197,217	121 10 0 0	1·38	.....	13·24	
,, ,, 31st July, 1910	125,357	61 0 0 0	1·09	....	11·99	
Period ending 31st Dec., 1910 ...	.....	74 0 0 0	.....	....	.....	Estimated from returns furnished to Department of Mines.
Totals	.....	1,145 2 0 0	.....	10,007 11 2	.. ...	

Proportional costs are shown by the following figures from the Half-yearly Report, ıding 31st July, 1907. Dredges, Nos. 1 to 4 :—

	£	s.	d.
Wages	5,551	14	6
Fuel	1,967	12	7
Stores	533	4	11
Charges	58	16	2
	£8,111	8	2

Stella Dredging Company.—M.Ls. 16, 17, 18, Parish Clive, County Gough, he Ponds Creek, about 3½ miles E.S.E. of Gilgai.

Operations commenced about September, 1907, and continued for four ıonths only. Portable engine used. Overburden about 18 feet thick, con- sting of yellow sandy clay and a few feet of drift sand. Small patches of oarse angular wash-dirt occurred at intervals, on an uneven bottom of hard ranite. The ground was mostly poor, and the tin ore gave out. About tons were obtained during operations.

Summerhill Dredging Company.—At head of Summerhill Creek. M.L. 36, 'arish Cope's Creek, County Hardinge, 4 miles E.S.E. of Tingha.

Operations commenced about 1906, but only continued for a few months. 'he overburden averaged 12 feet in thickness, and consisted mostly of granite and with a little clay. The wash-dirt was fairly rich at the upper end, but ecame very poor down stream. Plant operated by portable engines. 1½ ons of coarse angular tin ore were obtained from 500 yards of material. 'rospecting plant only.

Tingha South Tin-dredging Company.
Tingha South No. 1 Tin-dredging Company. } See Tingha Consolidated.

Tingha Tinr-dedging Company (*No Liability*).—In Cope's Creek, about 4 nd 4½ miles north-west of Tingha.

Work commenced January 7th, 1907.

No. 1 Plant.—About 4½ miles north-west of Tingha. Consists of barge arrying engines and necessary gravel and nozzle pumps. The material luiced when in operation consisted of :—

6 to 12 feet loose creek sand.
2 feet coarse angular stony wash, with fragments of slate and quartzite, and fine tin ore.
Bedrock, slate, with granite boulders.

No. 2 Plant.—Cope's Creek, about ¾ mile above No. 1. Consists of two Robey portable engines, 16 and 20 horse-power, and 10-inch gravel and nozzle ıumps.

Working up-stream, on a face 2 chains wide, in latter part of 1909, showing he following section :—

6 to 7 feet loose white sand.
2 feet coarse wash-dirt, containing angular fragments of quartzite and slate, with tin ore.
Slate bedrock, with granite boulders.

Tin ore fine-grained, and of dark reddish colour.

No. 3 Plant.—Cope's Creek, at village of Copeton. Consists of two 16 horse-power portable engines, with 10-inch gravel and nozzle pumps.

The overburden averages 12 feet, mostly fine sandy drift. The underlying wash-dirt is very coarse, with angular fragments of quartz, granite, and altered rocks, and averages about 14 lb. of medium-grained tin ore per load. The channel runs about 5 chains wide. Bottom uneven, with occasional bars and granite boulders. No tin in overburden.

The output of tin in 1906 and 1907 is given as follows:—*

	1906.	1907.
No. 1 Dredge ...	87 tons 1 cwt. 3 qrs. 6 lb.	... 46 tons 14 cwt. 1 qr. 27 lb.
No. 2 ,, ...	18 ,, 7 ,, 0 ,, 6 ,,	... 68 ,, 19 ,, 0 ,, 0 ,,
No. 3 ,, ...	71 ,, 18 ,, 0 ,, 1 ,,	... 44 ,, 19 ,, 2 ,, 18 ,,

Tingha South Tin-dredging Company.—(*See* "Tingha Consolidated.)

Union Tin-dredging Company.—Murray's Water. A. N. Buzacott, 70 Pitt-street, Sydney, Legal Manager.

Operating in Murray's Water, Parish Darby, County Hardinge.

In 1906 recovered 6 tons 14 cwt. 2 qrs. 12 lbs. of tin ore.†

In 1907 obtained 16 tons 18 cwt. of tin ore, from 55,000 cubic yards of material sluiced.‡

Wilberforce Dredging Company, No Liability.—(*See* Amalgamated).

(*b*)—Emmaville District.

Dredging and Hydraulic Sluicing Plants, Emmaville Division.

Bourke's Hill Tin Sluicing Company, No Liability, Emmaville (James Mackay, Legal Manager, 125 Queen-street, Melbourne). Capital 45,000 shares at 7s. 6d. each.

Operating at the head of the Graveyard Lead, on the east side of Y Water Holes Creek, Parish Scone, County Gough, about 2 miles south-easterly from Emmaville. Area 140 acres.

Two portable plants.. No. 1 plant consists of two 20 horse-power engines, one 10-inch Sands gravel pump, one 10-inch Sands nozzle pump. No. 2 plant consists of two 50 horse-power engines, one 30 horse-power pumping engine, one 12-inch Kershaw gravel pump, two 12-inch compound nozzle pumps, dynamo and generator.

Boxes 200 feet long, 9 to 12 feet wide. Large storage dam on Murdering Creek.

Overburden from 3 feet to 26 feet. Fairly good sluicing, in places requiring explosives.

Bouveret Syndicate Dredge, Graveyard Creek, Emmaville. Operating in old lead in M.Ls. 75, 193, Parish Scone, County Gough. Plant consists of a 14 and 10 horse-power engines, 35 horse-power boiler, 8-inch nozzle and gravel pumps. Average depth of ground, 3 to 6 feet. Porphyry bed rock. Water conserved in five dams; equal to six months supply when full. Sluicing began in June, 1910; 20 tons of tin-ore obtained to end of year, yield 1·9 lb. per cubic yard.

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* *Inverell Argus,* January 31st, 1908. † *Inverell Argus,* 5th February, 1907.
‡ Ann. Rept. Dept. Mines for 1907, p. 29.

Period.	Cubic yards Material treated.	Tin Ore Obtained.	Yield per cubic yard.	Cost per cubic yard.	Dividends paid.	Remarks.
		tons cwt. qrs. lb.	lb.	d.		
1. 4 Sept., 1906, to 31 Aug., 1907 ...	9,000 (approx.)	17 0 2 10	4·2	7·8	.....	Obtained with No. 1 portable plant; sluicing started 18th May, 1907.
2. 1 Sept., 1907, to 29 Feb., 1908 ...	50,000	35 3 0 0	1·574	.....	.....	No. 1 plant.
1 Sept., 1907, to 29 Feb., 1908 ...	19,000	17 3 0 0	2·0	.....	.....	No. 2 plant; worked part of period only.
3. 1 March, 1908, to 31 Aug., 1908...	48,000	30 10 0 0	1·4	.....	.....	No. 1 plant; five month's work; rate, 25 cubic yards per working hour.
1 March, 1908, to 31 Aug., 1908...	6,000	5 12 0 0	2·09	.....	.....	No. 2 plant; worked for short period only. Awaiting additional machinery.
4. 1 Sept., 1908, to 28 Feb., 1909 ...	33,523	25 17 0 0	1·72	.....	.....	No. 1 plant; worked 1,552 hours, at the rate of 21·6 cubic yards per hour. Plant stopped for nearly two months. Additional engine and pump installed to return water.
1 Sept., 1908, to 28 Feb., 1909 ...	54,000	42 14 0 0	1·76	.....	.....	No. 2 plant; worked 2,000 hours, at the rate of 27 cubic yards per hour.
5. 1 March, 1909, to 31 Aug., 1909...	54,400	48 5 0 0	1·98	9·25	No. 1— £1,125	No. 1 worked continuously; 14 acres purchased for tailing dump, forming additional storage for stormwater.
1 March, 1909, to 31 Aug., 1909...	65,000	57 15 0 0	1·97			No. 2 worked continuously. Water supply good.
6. 1 Sept., 1909, to 28 Feb., 1910 ...	61,500	50 0 0 0	1·8	.....	.....	No. 1 plant, continuous work; average quality of material, explosives used.
1 Sept., 1909, to 28 Feb., 1910 ...	47,000	40 0 0 0	1·9	.....	Nos. 2 & 3— £2,250	No. 2 plant, delayed by removal to fresh site. Boxes increased from 9 to 12 feet wide, owing to fineness of ore.
7. 1 March, 1910, to 31 Aug., 1910...	56,500	34 0 0 0	1·36	10·34	Nos. 4 & 5— £2,250	Both plants ran continuously. Ground hard for No. 1 plant. Explosives increased cost.
1 March, 1910, to 31 Aug., 1910...	78,000	52 15 0 0	1·97	9·97	.....	Height of both top dams increased.
8. 1 Sept., 1910, to 28 Feb., 1911 ...	86,900	37 7 0 0 15 10 0 0	.....	.....	No. 6— £1,125	No. 1 plant, yield for five and a half months. No. 2 plant, yield for two and a half months. Operations restricted owing to insufficient water supply to keep both plants sluicing continuously. McKinnon's block, adjoining, tested and secured.
Tota	668,823	508 11 2 10	1·70 average		£6,750	

Bullock Swamp Sluicing Plant, 6 miles N.E. of Emmaville. Lloyd and party. Small sluicing plant employed during 1908; sluicing surfacing on side of hill, near Glen Creek; ground 3 to 4 feet deep; water pumped from Glen Creek by 16-h.p. engine; ground sluices in use, five men employed. Two tons of tin ore obtained for about three months work.*

Elsie Tin-dredging Company, Tent Hill, 4 miles east of Emmaville, Parish Tent Hill, County Gough; area, 90 acres. Plant—two 20 h.p. Robey engines, with 10-inch gravel and nozzle pumps. Boxes 150 feet long, 7 feet wide; water pumped from Glen Creek, distant 1½ mile; ground about 26 feet deep on average; overburden clayey. Sluicing began early in June, 1907, and continued, with exception of three weeks, to end of year.†

In 1908, 78,454 cubic yards of material were sluiced for 58 tons of tin ore; equal to 1·6 lb. per cubic yard.

In 1909 the Tent Hill Sluicing Company, Ltd., was formed, to take over the Elsie property and plant. Capital, £4,500, in 30,000 shares of 3s. each. Possession being taken on the 8th April, 1909.

From the Director's report at the statutory ordinary general meeting, June 1st, 1909, it appears that it was found impossible to profitable run the existing plant; it was, therefore, closed down and overhauled.

It was decided to add an additional engine and boiler, a 10-inch nozzle pump, larger boxes, suitable piping, nozzles, &c.

Arrangements were also made for construction of a dam on the adjoining land of J. H. Reid & Co., to avoid the heavy cost of pumping from Glen Creek.

Sluicing operations with the new plant began November 26th, 1909, and continued until the 9th April, 1910, when they finally ceased.

From Nov. 26th, 1909, to Feb. 5th, 1910, 23,420 cubic yards of material for the south boundary were treated for an average return of 0·93 lbs. per cubic yard. The bottom then changed from rough and stony to flat and smooth, under a deep sandy overburden, which had been thoroughly cleaned up by the orginal miners. From this area to 12th March, 16,972 cubic yards were treated for a return of 0·35 lbs. per cubic yard.

A paddock was then sluiced 120 feet northerly, 8,443 cubic yards yielding 0·63 lb. per yard.

The total yield was 14 tons 14 cwt. 1 gr. 19 lb. from 48,655 cubic yards, equal to 0·67 lb. per cubic yard.

Grampian Dredging Company, Vegetable Creek, T. H. Martyn, Legal Manager, 117 Pitt-street, Sydney.—Purchased and removed a powerful dredging plant (bucket type) from Mogg's Swamp, near Mitchell River, Oban district, and erected it at Emu Flat, Vegetable Creek, during 1910. Dredging began in February, 1911, in M.L. 49.

Great Britain Sluicing Company, Limited.—R. N. Kirk, Secretary, 16 O'Connell-street, Sydney.—Operating in the old Great Britain Mine at the head of Vegetable Creek, Emmaville. Area 580 acres freehold. Capital, £5,000, in 10,000 shares at 10s. each.

Plant.—Two portable engines, with "Sands" 8-inch nozzle and gravel pumps.

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* Ann. Rept. Dept. Mines for 1908, p 52. † Ann. Rept. Dept. Mines for 1907, p. 29.

Dredging began November, 1907, working old ground, the richer part of which was blocked out in the early days of mining. Tin lightly distributed through the overburden, much stone present. Cemented bed in places necessitates use of explosives. In the joints of the felsitic bed-rock, tinstone of a ruby colour occurs in extremely fine seams.

The Great Britain Mine was probably one of the richest claims on Vegetable Creek, if not the richest, the yield from it between 1872 and 1880 amounting to 3,424 tons of tin ore. The ground has been continuously worked since then by tributors, producing a small tonnage annually. Considerable doubt was first entertained as to the prospect of profitable sluicing with the new method of suction pumps, on account of the large proportion of flat stones in the wash and overburden, and the rough and uneven bottom and the limited catchment for adequate water supply.

Ultimately a syndicate decided to test it with a small portable plant with 8-inch gravel pump. This succeeded so well that in 1909 a larger plant, with 10-inch Sands pumps, was erected, capable of dealing with nearly double the amount of material treated by the smaller plant. A 25 h.-p. engine provided for gravel pump, two 14 h.-p. engines used for compound-power pump by intermediate gearing. Lift to boxes, 38 feet vertical.

In 1909 the Company decided to exercise an option secured to work Moore's Estate and the Rothschild blocks lower down Vegetable Creek, the terms being a royalty of 12½ per cent. of the net profits and 1,265 fully paid-up shares. To equip Moore's ground it was wisely decided to set aside a portion of future profits concurrently with payment of further dividends, the time allowed for instalment of plant being until 30 June, 1910. The portable dredging plant installed near the Severn River, about 14 miles from Glen Innes, by the Commonwealth Dredging Company, was purchased for Moore's ground, and sluicing operations started on the 4th April, 1910. Of the cost of plant and dams—£1,223 3s. 5d.—£1,026 14s. 4d. was paid from the Great Britain profits during the half-year ending 23rd April, 1910.

As this company operates with portable plants instead of floating barges, it is interesting to record the time occupied, and cost of removal to new sites. The following figures are quoted from the Company's published reports :—

1st move,	Feb., 1908 ;	time occupied,	6½	days ;	cost, £115.
2nd „	June, 1908 :	„	5	„	„ £122.
3rd „	Feb., 1909 ;	„	5	„	„ not stated.
4th „	June, 1909 ;	„	5	„	„ £135.
5th „	Nov., 1909 ;	„	2 days 16 hours,		cost, £120.
6th „	Feb., 1910 ;	„	1 day 21 hours,		„ £100.

GREAT Britain Sluicing Company (Ltd.), Emmaville. (Returns compiled from Company's Half-yearly Reports.)

Period.	Cubic yards Material treated.	Yield of Tin Ore.	Yield per cubic yard.	Cost per cubic yard.	Dividends paid.	Remarks.
		tons. cwt. qrs. lb.	lb.			
1st Ord. Gen. Meeting 29th May, 1908	27,177	35 18 0 0	2·9	.....	.....	Plant taken over 13th November; moved to second site in February, 1908; average depth of ground, 6 to 8 feet; three dams constructed; rate of sluicing, 11·5 cubic yards per hour.
2nd ,, ,, 27th November, 1908...	40,579	58 0 3 24	3·2	.....	.....	Rate of sluicing, 13·2 cubic yards per hour; lead 10 chains wide, depth 9 feet; explosives used in bed of cement, 1 ft. 6 in. to 4 feet thick, on south side; profits devoted to increasing plant.
3rd ,, ,, 28th May, 1909	48,409	63 8 3 8	2·93	.....	No. 1—£436 15s.	Rate of sluicing, 17·7 cubic yards per hour; new plant started 1st March; hard rock bottom increased cost of race cutting to pump; plant being paid for out of profits.
4th ,, ,, 26th November, 1909...	74,100	82 17 3 19	2·5	.....	Nos. 2 to 4—£1,310 5s.	Rate of sluicing, 27·8 cubic yards per hour; plant only once moved; use of extended suction up to 200 feet enabled large paddocks to be worked; area worked for half-year 4½ acres; averaging 11 feet deep, and 8 or 9 chains in width.

5th	,,	,,	27th May, 1910	75,472	63	11	3	6	1·18	.....	No. 5—£436 15s.	Heavy deposits of cement encountered on southern side of lead; overburden nearly all strippings, hopperings, &c., from early workings, which had been reworked prior to present operations; plant removed twice; area worked, about 5½ acres; average depth, 9 feet.
5th	,,		,, ...	3,759	2	16	3	1	1·69	.....	.....	Moore's Ground plant; 119 hours sluicing.
6th	,,	,,	2n December, 1910 ...	80,560	68	8	2	23	1·90	.....	Nos. 6 to 8—£1,500.	Great Britain Ground; plant removed three times; area worked $6\frac{7}{10}$ acres; lead much narrower; cement continues on south side.
6th	,,	,,	,, ...	66,205	54	15	0	22	1·85	.....		Moore's Plant; twice moved; area worked $5\frac{11}{20}$ acres; lead 7 chains wide, narrowed to 4 chains; less cement than in Britain ground.
Period from 5th November, to 31st December, 1910.				18,000 25,300	16 22	2 18	2 2	14 25	2·0	.....		
Totals				459,561	468	19	2	2	2·28 av'ge.	.....	£3,683 15s.	

Stanthorpe Proprietary Tin-dredging Company, T. H. Martyn, General Manager, 117 Pitt-street, Sydney. Site, Old Minnie Claim, on Vegetable Creek, immediately below Moore and Speare's ground.

Plant consists of a bucket dredge on barge 85 feet by 30 feet by 5 feet, 25 h.-p. boiler, and 18 h.-p. engine. Electric lighting plant.

The material from the buckets falls into a trommel screen, and on the tables is kept stirred by travelling rakes on link chains with sprocket wheels.

A dam was constructed and the plant erected by the 13th January, 1910, sluicing began on the 18th. The alluvial along the south bank of the stream was ploughed up and carted to the dredge.

The following statements have been kindly supplied by the General Manager, under date 10th October and 23rd December, 1910 :—

"Commenced dredging 12th February, 1910. To 30th September, 82,113 cubic yards of material have been treated for a return of 64 tons 7 cwt. of stream tin, equal to 1·75 lb. per cubic yard."

"From 1st October to 17th December, 41,239 cubic yards were treated for 22 tons 14 cwt. of tin ore, equal to 1·3 lb. per cubic yard."

Sturtridge and Schumacher's Dredge, Emmaville.—MLs. 25–27, 36, in upper portion of Vegetable Creek between Great Britain Mine and Tent Hill. A privately-owned plant, which is run when water is available. See Appendix A.

Y-Water (Emmaville) Tin Company N.L.—E. H. Shackell, Manager, 375 Collins-street, Melbourne (capital 60,000 ıares of £1 10s. each)* ; site of operations, Cadell's Freehold, Graveyard Lead, near Emmaville ; area, about 600 acres.

Over 100 men employed in preliminary work in 1906, constructing reservoir, cutting races, &c.

Erection of plant commenced in January, 1907, and sluicing in July ; difficulty encountered in working barge to bedrock, which was reached at 47 ft. 6 in. from surface at end of year.

Plant consists of one 14-inch gravel, and two 16-inch nozzle, pumps ; the largest and most powerful dredging plant in the State. Cost, £14,500.

Barge, 70 feet x 40 feet. Three boilers, 200 h.-p. each. Five h.-p. engine and generator ; thirty-five dynamos ; and electric plant.

Y-Water (Emmaville) Tin Company (N.L.). (Return compiled from the Company's Half-yearly Reports.)

Period.	Cubic yards Material treated.	Yield of Tin Ore.	Yield per cubic yard.	Cost per cubic yard.	Dividends.	Remarks.
1. For period ended 31 Jan., 1907	.....	.....	.....	.....	.....	Reservoir of 65,000,000 gallons capacity begun. Order placed with Thompson & Co., of Castlemaine, Victoria, for large dredging plant. In course of construction.
2. ,, ,, 31 July, 1907	.....	.....	.....	.....	.....	Plant put under steam, 4th July. Alterations in nozzles necessary. Sluicing only intermittent to 5th August. Two shifts employed. Reservoir full.
3. ,, ,, 31 Jan., 1908	74,900	.. ..	.....	.....	.....	Barge landed on bedrock in paddock sluiced, at a depth of 47½ feet from surface. New dam constructed to control slurry. Tramway laid for handling firewood. Almost wholly over-burden sluiced.

Period.	Cubic yards Material treated.	Yield of Tin Ore.	Yield per cubic yard.	Cost per cubic yard.	Dividends.	Remarks.
		tons cwt. qrs. lb.	lb.			
4. For period ended 31 July, 1908	102,500	17 15 1 3	.....	.....	.....	Owing to abnormal quantity of slurry and clayballs great loss of fine tin occurred. Sluicing ceased 11th May, owing to failure of water supply. Tramway laid but not ballasted.
5. ,, ,, 31 Jan., 1909	22,100	17 11 3 5	5·0	.....	.....	Tailings retreated between 19th October and 3rd November.
6. ,, ,, 31 July, 1909	22,000	10 14 0 0	1·1	.....	.....	From lead. Grizzly erected at head of boxes. Sluicing only carried on for three weeks. Barge moved to new site. Tramway completed. Boxes widened to 24 feet,
7. ,, ,, 31 Jan., 1910	180,200	70 5 0 0	0·87	.....	.....	Permanent water supply from Severn River decided on. Gas-producer plant and five-stage turbine pump purchased. Orders placed for 3½ miles of iron and wood pipes. Depth of ground worked, 42 to 56 feet. Nozzle pressure in use, 30 lb. per sq. inch. Gravel pump lifting 103 feet. Width of boxes increased to 30 feet. Rate of sluicing, 83 cubic yards per hour.
8. ,, ,, 31 July, 1910	232,900	119 7 0 0	1·148	.....	.....	Net profit, £3,129 11s. Average price of tin £150 10s. 6d. Severn River water scheme completed at a total cost of £4,589 14s. 9d. Plant consists of a Hornsby gas engine and generator to carry a continuous load of 85 brake horse-power, belt drive, and five-stage centrifugal pump to deliver 500 gallons per minute. The pipe-line, 9-in. diameter, contains 12,000 feet of wood pipe, and 4,000 feet of galvanized steel pipe. Average depth of ground treated, 44 feet. Average lift of gravel pump, including pipe friction, 107 feet.
Period from 1 Aug. to 7 Dec., 1910	186,500	81 19 0 0	0·978	.....	.....	No. 9 report, for period ending 31st January, 1911, discloses a profit of £3,331 19s. 9d. for the half year.
	821,100	317 12 0 8	0·86 average.			

Deepwater Division.*

Dredging and Sluicing.

Stannum King Mine (formerly known as "The Coppers Tin Lode and Alluvial Mine").—M.Ls. 190, 191. Parish Romney, County Clive; about 8½ miles from Deepwater on the east bank of the Deepwater River, opposite Piercy's Hill.

The local name of "Coppers" is derived from characteristic "pot-holes" in the rocky bed of the river below the mines in question.

A well-defined quartz reef, carrying tin in small "bungs" or bunches strikes N. 10° E., or approximately parallel with, and 10 to 20 chains from the river. It is traceable between Portion 97 and Hamilton's Gully near the S.E. corner of Portion 30.

Between the reef and the river the slopes and ridges carry tin in the surface soil, and in old terraces near the river. Hamilton's Gully and other small channels have been ground-sluiced by water conserved in small dams in wet seasons. This gully meanders between large granite boulders. In the spoil from the races and from prospecting holes, grains of tinstone are freely visible. Hamilton's Gully is partially dammed by a hard granite bar where it crosses the northern strike of the reef. The elevation at this point is 120 feet above the river.

Near the S.W. corner of Portion 190, a 12-h.p. engine has been installed working a pump with 3-inch delivery to a small storage dam in Ryan's Gully. From the dam a sluice runs into a gutter showing rotten sedimentary bed-rock. Rich patches of tin ore were worked along the gully for a short distance, but the average is too low for such limited sluicing capacity being profitable, The alluvial has an average depth of 10 feet, and carries a little tin throughout according to report, but the principal tin values are confined to a few inches of coarse angular wash lying on the bottom. (For description of the tin lode on this property, see "Tin Lodes.")

Stannum Tin Dredging Company, N.L., Red Hill, Stannum, A. W. Buzacott, Secretary, 70 Pitt-street, Sydney; Capital, 32,000 shares of 5s. each.—M.Ls. 27, 29, 33–36, 38, 44, 45, 50, 51, and Portion 520. Parish Wellington Vale, County Gough. The Stannum Tin Company's leases being purchased for £3,408 cash.

Sluicing operations commenced in September, 1907.

Plant.—Two compound Robey portable engines, each 20 h.p.; 10-inch gravel and nozzle pumps. Sluice boxes, 6 feet wide, 2 feet deep; fall 6 inches in 9 feet.

Average depth of ground, 10 feet. Overburden mainly red sandy soil; bottom soft, but uneven. No boulders. A few thin quartz veins traverse the bedrock, carrying a little tinstone. The wash averages 2 feet in thickness, and consists of coarse angular stones with waterworn quartz pebbles. Area worked, about 7 acres to April, 1910. The material sluiced on Red Hill averages 2 lb. of fine waterworn black tin ore per cubic yard, averaging 70 per cent. metallic.

On the flats lying N.W, of Red Hill the average yield is estimated at 3 lb. per cubic yard of somewhat coarser and cleaner tin ore, averaging 74 per cent.

The output from 23rd September, 1907, to 31st October, 1908, was 40 tons 8 cwt. of dressed tin ore, from 32,800 cubic yards of material treated, equal to a yield of 2·89 lb. per cubic yard.

* A portable dredge was installed in Catarrh Creek, near Torrington, consisting of two 20 h.p. engines and 10-inch nozzle and gravel pumps. Dredging began early in 1909; shifted three times. About 6 tons of ore obtained—unpayable.

The output from 1st November, 1908, to 31st October, 1909, was 52 tons cwt. of dressed tin ore from 57,400 cubic yards, equal to 2·04 lb. per ubic yard. Fifty-one tons were obtained during 1910.

Torrington Swamps Tin Mining Company, N.L., Black Swamp Creek.—M.Ls. 31, 33, 38, 49. Parish Rock Vale, County Clive. About $4\frac{3}{4}$ miles N.W. of Torrington.

Plant—Two portable engines, 14 and 18 h.p.; 8-inch gravel and nozzle umps; electric light.

Operations commenced September, 1909; abandoned, 1910.

A large storage dam constructed about 1 mile up-stream from sluicing site. he average depth of overburden varies from 5 to 12 feet. The widest ortion of alluvial about 10 to 15 chains. The wash is more or less emented, and consists of angular and partly waterworn pebbles of slate, ranite, and quartz. The tin ore is partly waterworn, medium grade, and lack and ruby coloured. Monazite occurs in association.

After a few months work it was found that the prospects obtained by oring were not realisable by dredging—the percentage of tin obtained as not remunerative.*

(*c*)—Wilson's Downfall.

Dredges and Sluicing Claims.

Border Sluicing Company's Dredge, in M.L. 327.—Parish Ruby, County uller. Six miles N.N.W. of Wilson's Downfall, on Seven-mile or Herding ard Creek.

Pumping plant, valued at £3,000, erected in 1906; sluicing operations ommencing towards end of September. Plant consisted of two portable ngines and boilers, nozzle and gravel pumps.

Average depth of overburden, 16 to 22 feet, deepest on right bank of eek, and consisting of black puggy soil, granite sand with bluish clay, with inches of coarse, angular, very stony wash. Bedrock mostly hard and neven. Gravel consists of reef quartz, chalcedony, aplitic and graphic anite. Bedrock, porphyritic sphene-granite with large basic inclusions, aversed in places by aplite bars trending N.E. The numerous bars ampered dredging operations. Seventeen thousand cubic yards were treated om the first excavation near the Maryland-road, but results proving un-tisfactory the plant was moved a few chains up-stream, where a further xcavation resulted similarly. A third was then made about 20 chains rther up-stream, near the junction of a small right-hand tributary, where the reatest depth—22 feet—occurred. A very small quantity of tin only being btained, operations were abandoned, after about eight months trial; the ant being dismantled and removed in 1907.

The gravel along this channel occurs in narrow runs of a patchy character, nd fairly highly cemented. Black sand is plentiful in the wash. Prac-cally, no tin occurs in the overburden. The tin ore obtained was fine and aterworn, black and ruby coloured. The limited tin values, depth of arren overburden, frequent bars, and narrow, patchy leads, renders it nlikely that this portion of the channel could be profitably worked.

Dixon's Creek Tin Dredging Company, Ruby Creek, M.L. 6, Parish Ruby, ounty Buller, 7 miles north-west of Wilson's Downfall.

Operations begun in July, 1909, and continued to December of same year, mmencing at north-west end of M.L. 6 and worked up stream, mainly in d of creek.

* A dredging plant was established at Flagstone Creek, near Torrington, but operations were unremunerative.

Plant.—Barge, with 150 h.-p. dry-back marine tubular boiler ; two engines, 100 and 50 h.p., condenser, electric light, 10 inch gravel pump, and 12 inch nozzle pump.

Average depth of overburden, 12 feet. Bedrock usually soft granite, with hard bars, and huge boulders. Overburden—granite, sand, and clay.

The richest deposit occurred at junction of Telegraph Swamp, at south-east corner of M.L. 6. Operations were abandoned at this point, most of the dredgable ground having been treated. It was intended to eventually dredge Dixon's Gully, some 3 miles south-west of M.L. 6, but the prospecting returns were not sufficiently encouraging to warrant removal to that site.

Approximately, 20 tons of fine water-worn tin ore were extracted. Black sand was practically absent. Occasional sapphires, topazes, and specks of gold accompanied the tin.

Herding Yard Tin Dredging Company N.L. (T. H. Martyn, General Manager, 117, Pitt-street, Sydney).—M.C.Ps. 31 to 48, Parish Ruby, County Buller, on Herding Yard Creek, at Amosfield, $2\frac{1}{4}$ miles north-west of Wilson's Downfall.

Construction of dam and erection of bucket dredge begun in 1907, dredging operations began in old abandoned workings in M.C.Ps. 45, 46.

By the end of the first quarter of 1910 about 15 acres of ground had been dredged up stream into portions 40 and 37, where the Stanthorpe-road was dredged across, a temporary deviation being constructed for the purpose.

The plant consists of forty-two mild steel buckets, weighing 6 cwt. each, of a capacity of 3 cubic feet, with pins of manganese steel ; 16 h.p. compound condensing engine ; 10 h.-p. winch engine ; 20 h.p. multitubular boiler ; revolving trommel screen ; Martyn's patent rakes—an ingenious contrivance of travelling rakes, with teeth of pliant steel, worked by link belts, to keep material moving on tables.

The capacity of plant amounts to about 75 cubic yards per hour, on a fuel consumption of 14 cords per week. Working three shifts and employing twenty-two hands.

The overburden averages 9 feet in depth, consisting of granite sand, with lumps of blue clay. Being old worked ground trouble is experienced with "props" and other mine timber, and occasional logs.

The width of channel worked averages 400 feet, but actual width of stanniferous alluvial is greater ; a considerable area being left near north side of Stanthorpe-road, owing to a high bar of rock preventing the barge floating ; average yield of the left portion, by boring tests, about $1\frac{1}{4}$ lb. tin ore per cubic yard.

The bed rock consists of soft granite, fairly even, with occasional boulders.

Black sand is associated with the tin ore in the wash, also occasional small sapphires, topazes, &c., and odd specks of gold.

The tin ore is fairly coarse and partly water-worn, ruby and black coloured.

Mr. T. H. Martyn states that dredging commenced 22nd August, 1909, and up to 1st October, 1910, 403,089 cubic yards of material were treated for 173 tons 16 cwt. of stream tin, equal to 0·96 lb. per cubic yard. From 1st October to 17th December 69,950 cubic yards were treated for 35 tons 2 cwt. of tin ore, averaging 1·1 lb. per cubic yard—a total production to date of 208 tons 18 cwt. of tin ore, averaging 0·98 lb. per yard.

During the year the company paid three dividends of 1s. each on its capital of 10,000 shares.

Micalong Mining Company.—M.Ls. 3, 4, 326, Parish Ruby, County Buller, on Ruby Creek, $5\frac{3}{4}$ miles north-west of Wilson's Downfall.

Near Hindmarsh Swamp 4. Dredge, Hindmarsh Creek, Wilson's Downfall

Construction of dam and erection of plant begun in 1906; dredging began n January, 1907, at north end of M.L. 326, and continued up stream.

Plant consisted of barge with 99 h.p. semi-portable engine of half loco- ype, Kershaw 10 inch nozzle, and 12 inch gravel pumps; capacity—actual ork—40 cubic yards per hour.

The overburden treated in M.L. 326 averaged from 9 to 12 feet in depth, nd consisted of granite-sand and clay on a usually soft granite bedrock, ith hard bars at intervals, uneven, but free of boulders. Yield about 10 oz. ater-worn ruby and black tin ore per cubic yard, free from black sand.

The overburden in M.L. 3 ranges from 14 to 18 feet in depth. Operations ere much hampered by shortage of water; a large supply dam was onstructed a short distance up stream from the Stanthorpe-road.

Operations ceased after intermittent work for about two years. For eight onths in 1908, 38 tons of tin ore were obtained.* During the period men- ioned the tin values were a little less than working expenses.

New Wylie Creek Tin-dredging Company (N.L.).—Capital, £24,000, in 8,000 shares at 10s. R. N. Kirk, Manager, 16, O'Connell-street, Sydney.

This was the pioneer dredging company in the Wilson's Downfall Division, arting originally under the title of the Wylie Tin Dredging Company, N.L. eformed or reconstructed in 1902 under present title. Installed bucket redge in 1901–2, but unable to start regular work before June, 1903, owing o continued drought. This plant was shut down in July, 1908, having xhausted the available ground that could be profitably worked by this class f plant.

A suction plant capable of treating not less than 5,400 cubic yards of olid matter per week was installed during 1907–8, at a cost of £4,220 for lant alone.

The site of operations being M.Ls. 309, 311, 312, 319, 321, Parish Wylie, ounty Buller, 2½ to 3 miles north-north-east of Wilson's Downfall.

The bucket dredge between 1903 and 1908 dredged about 60 acres, pstream. The fuel consumption amounted to about twelve cords per week. he ground averaged about 11 feet in depth. Starting near the north-west orner of M.L. 312, it worked along the creek through M.Ls. 312, 311, and ie northern end of 309. This area was mostly old worked ground. The aterial treated consisted of granite-sand with some clay, resting on a soft ut very uneven granite bedrock. Tin ore occurred distributed all through the verburden. The bottom was somewhat bouldery, but not sufficiently so to npede progress. A considerable quantity of black sand accompanied the n ore.

Two large dams were constructed, impounding an ample water supply. Vhilst in operation three shifts were employed, totalling 22 hands.

The suction dredge began operations in 1908 at the north end of M.L. 21, and had worked up stream to the centre of M.L. 319 in the beginning 1910. This plant consists of two 60 h.-p. engines, 12 inch nozzle, and 10 ch gravel pumps, electric lighting plant, &c.

The fuel consumption amounts to 45 cords per week. When three shifts e worked 28 men are employed. The yield, so far, averages from ¾ to 1¼ . per cubic yard, of fine partly abraded black and ruby tin ore.

The black sand—chiefly magnetite and ilmenite—rejected from ordinary eaning operations, yielded on assay at the rate of 2·40 per cent. metallic tin.

* Ann. Rept. Dept. Mines for 1908, p. 27.

NEW Wylie Creek Tin-dredging Company (N.L.), Wylie Creek, Wilson's Downfall. (Compiled from Company's Reports.)

Period.	Material Treated.	Tin Ore obtained.	Yield per cubic yard.	Dividends Paid.	Remarks.
	cubic yds.	tons. cwt. qrs. lb.	lb.	£ s. d.	
1st Annual Report, dated 28 October, 1901...	.....	.....	.....	.....	Pontoon launched 26th August. Cost of pontoon, £1,574 9s. 8d.; cost of machinery, £3,693 19s. 3d.; total, £5,268 8s. 11d.
1902	.....	.....	.....	.....	Drought; no work done.
1st Ordinary general meeting, 8 Oct, 1903 ...	47,641	15 5 0 0	1·39	.. ..	Company reconstructed under name of New Wylie Tin Dredging Company, N.L.; drought continued for six months; regular work began in June; large dam constructed.
2nd ,, ,, 18 Apr., 1904...	127,030	47 6 1 19	1·2	1,105 3 3	£660 paid off debenture account; £250 transferred to contingency account.
3rd ,, ,, 10 Oct., 1904...	.....	35 6 0 0	.....	736 15 6	£250 to contingency account; dredge transferred to opposite bank, which proved poorer.
4th ,, ,, 10 Apr., 1905..	.....	43 0 0 0	.....	736 15 6	£250 to contingency account; dam being constructed higher up stream; large amount of low grade material treated; some rich patches.
5th ,, ,, 30 Oct., 1805...	.....	32 10 0 0	.....	1,105 3 3	£350 to contingency account; dredge entered narrow channel in June, very poor for 250 yards; bar of rocks caused delay.
6th ,, ,, 23 Apr., 1906...	....	16 14 3 22	.....	.....	Ground worked shallow, rocky, and poor. New dam carried away by flood;

7th	,,	,,	22 Oct., 1906...	....	26	7	0	14	½ lb. (about).	368 7 9	£100 to contingency account; ground towards China Town proved poor and narrow.
8th	,,	,,	6 May, 1907...	.....	41	13	2	6	.....	2,210 6 6	£590 12s. 6d. to contingency account; lower blocks bored, proving profitable ground. Arrangements made for suction dredge.
9th	,,	,,	28 Oct., 1007...	.....	29	17	2	10	.....	736 15 6	£200 to contingency account; contract let for suction plant for £4,220, ground treated consistently poor; China Town dam to be raised 2 feet; 9-feet water-wheel erected below main dam for power to drive lathe, drilling machine, &c. Average price obtained for tin ore, £117 per ton.
10th	,,	,,	4 May, 1908...	.....	29	19	1	9	.....	.....	New plant under steam for several shifts; ground poorer than expected. Average price obtained for tin ore, £86 14s. per ton.
11th	,,	,,	26 Oct., 1908...	.....	25	15	0	21	.....	.....	Loss on operations for half year, £342 7s. (bucket dredge responsible for £306 8s.); bucket dredge stopped 3rd July. Average price obtained for tin ore, £90 8s. 5d. per ton.
12th	,,	,,	26 Apr., 1909...	90,000	48	7	0	10	1·2	368 7 9	Bucket dredge idle.
13th	,,	,,	23 Dec., 1909...	85,657	30	19	1	25	0·81	.....	Contending with an extensive bar, from 2nd May to 20th August. Dredging ground narrow.
14th	,,	,,	27 Apr., 1910...	78,765	30	15	0	0	0·87	.....	Ground clayey; bottom hard.
15th	,,	,,	26 Oct., 1910...	.....	14	15	0	0	.....	.....	Plant moved 266 feet.
Period from 15th report to 31 Dec., 1910 ...				.....	6	13	3	0	.....	.....	....
TOTAL				.....	475	5	1	24	.....	£7,367 15 0	

Stormer's Ridge Dredging Company. Portions 13, 15, 16, 17, &c.; on Stormer's Ridge and New Zealand Gully. Parish Ruby, County Buller; 7 miles N.W. of Wilson's Downfall, near Queensland Border; about ¾ mile north of Stanthorpe-road.

Construction of dams and erection of plant began in 1908; sluicing began at end of May, 1909. 19 tons of tin ore won to end of year.

Plant consisted of two portable engines, and large supply dam in M.L. 25 at junction of Dixon's Gully with Ruby Creek, from which water was pumped to dredge.

Much of the area sluiced was very shallow, varying from surface to 9 feet. A little tin ore occurred throughout, mostly fine and water-worn; ruby, and black-coloured. No black sand associated. Operations, hampered by want of water, continued for a few months only. Plant now idle.

Two-mile Tin-dredging Company (Limited). Two-mile Creek and its tributaries. M.Ls. 1, 6, 7, 9; Parish Corry, County Buller.

Operations began in M.L. 1 in September, 1909, working up-stream. Plant consists of barge, carrying 150 horse-power dry-back marine tubular boiler; two engines, 100 and 50 horse-power; condenser, electric light, 10-inch gravel, and 12-inch nozzle-pumps.

Ground mostly shallow—1 to 9 feet—reaching 15 feet in Murson's Branch. Overburden consists of a little black soil, granite sand, and some clay, resting on gravel composed of angular pieces of eurite, white quartz, and quartz crystals, both clear and smoky. The eurite bedrock is very uneven, and traversed by numerous hard bars, and more or less strewn with water-worn eurite boulders. The alluvial averages about 10 chains in width in places, and yields 12 to 13 oz. of tin ore per cubic yard in the Two-mile, and 1½ lb. in Murson's Branch. The average thickness of the gravel wash in the latter is 18 inches, and is of similar nature to that in the Two-mile.

A large supply dam has been constructed at Fern Swamp, in M.L. 6. It is intended to work the Swamp, which has an average depth of 9 feet of overburden.

The Company had dredged about 3 acres to February, 1910, for a yield of 12 tons of mostly fine water-worn ruby and black tin ore, with some coarse and angular. Operations were then being carried out partly in M.L. 1 and and partly in M.L. 6. The yield reported* between October and 31st December being 34,650 cubic yards for 8 tons of ore, equal to 0·51 lb. per cubic yard recovery.

Much black sand occurs near the surface, but little in the wash. A little fine tin ore occurs through the overburden. Very occasional sapphires occur. The rise in the bedrock up-stream is likely to cause much difficulty in moving the barge.

T.M.D. Syndicate's Sluicing Claim. Near west bank of Ruby Creek; Parish Ruby, County Buller; about 330 yards below the junction of Mossman's Gully; 6 miles N.W. of Wilson's Downfall, near the Stanthorpe-road.

Worked by Messrs. Turner, Markham, and Davis. Operations commenced in January, 1910. An 8 horse-power portable engine employed pumping water from settling dam in Ruby Creek to storage dam at head of workings; the water thus being re-employed.

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* Ann. Rept. Dept. Mines or 1909, p. 27.

Material treated is granite sand, forming a surface deposit of some extent above the creek bed. Bed-rock soft and uneven. Insufficiency of fall causes some difficulty. The first fortnight's operations yielded 4 cwt. of very fine water-worn tin ore, ruby and black-coloured. Coarse tin ore was also present. The average yield was 3 lb. per cubic yard. Odd specks of gold occur in the drift.

(*d*)—Other Localities.

Bendemeer Division.—Dredging.

In 1905 the *Scottish Consolidated Tin Mining Company* secured 226 acres on Watson's Creek, and commenced erection of a bucket dredge at an estimated cost of £7,000.

Operations began in November, 1906; work to close of year being of a preliminary nature. The dredge was found capable of removing 90 cubic yards of material per hour, according to report. Good wash was at first obtained, but proved very limited. Much of overburden cemented. Depth of ground, 21 feet.

The yield in 1907 did not come up to expectations; a considerable portion of the ground proved practically barren. An attempt was then made, by means of a portable engine and centrifugal pump, to prove ahead of the dredge. Two paddocks were excavated, the second of which disclosed some tin-bearing wash; a start was, therefore, made to work the dredge in that direction. The overburden proved exceedingly hard, necessitating explosives. The average depth was 20 feet, and the tin ore was confined to a few inches of wash lying on the bedrock.

The method of work adopted was to strip the overburden—which was not passed through the sluice-boxes—and to use it for damming purposes behind the dredge.

In 1909 two dredging leases were taken up by A. G. Friend below the above Company's leases on Watson's Creek, constituting the scene of operations of the Den Dredging Company, which unsuccessfully conducted dredging for part of this year. The ground worked at end of year averaged 24 feet in depth, the upper 12 feet requiring blasting.

The tin ore was confined to about 1 foot of wash on the bedrock, and the yield for the whole material excavated averaged not more than ½ lb. per cubic yard.

Other areas were secured for dredging purposes, but the inducements have not been sufficient for holders to start active work.*

Commonwealth Tin Dredging Company N.L. P.M.L. 25; Parish Wellington, County Gough; near Glen Innes–Emmaville road, about 14 miles from Glen Innes.

Stationary plant: 30-horse-power Robey engine, 20-horse-power Garrett and Sons' engine, 10-inch Sands' nozzle and gravel pumps.

This plant was installed to rework an old alluvial lead of very short length, until it passes under basalt at its upper end. The catchment being very limited, the water supply was naturally inadequate. The ground is deep and puggy, passing in a short distance to 60 feet deep. At this point a shaft was sunk by the original prospectors to 60 feet level, and driven, under aid from

* Extracted from Ann. Repts. Dept. Mines for 1907–1909. See also pages 290-292.

the Prospecting Vote, for a considerable distance under the basalt. Water was heavy, requiring steam-pumping power. From this shaft it was pumped for the engines of the dredging plant. The country rock is quartz-felspar-porphyry. The dredging plant was shifted from the lower end to about midway to the basalt.

The output during operations is recorded as 24 tons of tin ore,* valued at £2,000.

The site was ill-chosen, as the ground was limited, deep, and clayey, and water deficient for sluicing purposes.

Early in January, 1910, the plant was disposed of to the Great Britain Tin Mining Company, and shortly afterwards removed to Moore and Speare's land, Vegetable Creek.

Glen Elgin Gold and Dredging Company.—M.Ls., Parishes Glen Elgin and Binny, County Clive.

Plant.—Bucket dredge, valued at £6,700.

Work began in the Rocky River, towards the end of April, 1906, in both stream and banks. Estimated 186,430 cubic yards were treated by the end of year, for a yield of 506 oz. of gold, and 2 tons 6¾ cwt. of tin ore. The gold equalled 1·30 grains per cubic yard.

In 1902 operations had to be suspended in September, owing to water scarcity. 146,500 cubic yards were treated for 247 oz. of gold, and 1 ton 11 cwt. of tin ore.

During 1903 to 1906 operations were continued, but with very disappointing results. In 1907 the plant was dismantled and removed.

Subsequently some of the tributary creeks, and the high banks above the river were bored; the results proved the values to be too erratic and too poor to pay for sluicing.

Rand Dredging Company.—M.L. 3, Parish Bloxsome, County Gough.

In Severn River, near Bald Nob. The Rand Dredging Company erected a Jennings Pump dredge at this site about the beginning of 1907; but after excavation of a small paddock, the plant was removed.

Kookabookra Division (now Glen Innes).

Guyra Tin Dredging Company.—This Company in 1903 erected a suction dredging plant at Backwater, Oban, and commenced work in December, Three weeks run gave 2 oz. of gold, and 1½ tons of tin ore.

In 1904 the plant was worked intermittently with poor results; being let on tribute towards end of year.

In this year three small pumping plants were at work in this Division, two on Oban River commenced operations during latter half of year. Output 80 oz. gold, and 8 tons of tin ore.

Mitchell River.—In 1901 a Newcastle syndicate started dredging operations in the Mitchell River, with a suction plant, the results, however, proved unremunerative.

Mogg's or Jacob's Swamp.—Parish Worra, County Gresham.

A powerful dredging plant was installed at this site in 1907, by the Worra Gold Dredging Company, at considerable outlay; the plant was idle at the close of the year, pending completion of alterations, and later was sold and removed.

* Ann. Rept. Dept. Mines for 1909, p. 52.

In 1909 the site was abandoned. The plant was subsequently sold in 1910 to the Grampians Tin Dredging Company, and removed to Emu Flat, Vegetable Creek.

Stratton's Dredge.—Mitchell River, near Oban. L. F. Harper reported in the latter part of 1910 :—

"A suction dredge is at work on the Mitchell River, in Parish Zara, County Gresham, about 33 miles east-south-east of Glen Innes.

"Mr. David Stratton is the proprietor, and holds three gold leases, Nos. 9, 16, and 18, the dredge at present working on G.L. 9. Mr. A. A. Thomas, Manager, supplied the following information :—

"A 34 horse-power boiler is installed on the dredge, and works a 10-inch nozzle pump, and one 8-inch gravel pump, with a capacity of 40 cubic yards per hour.

"Sixteen men are employed in connection with the dredge, and under favourable conditions three shifts per day are worked.

"The river gravels are fairly extensive and free from large boulders, and the gold and tin contents are estimated to be worth about 8d. per cubic yard, but the dredge is at present on much richer ground.

"About 16 feet of overburden is underlain by from 4 inches to 1 foot of wash, which besides gold and tin ore, contains an undesirably large percentage of titaniferous iron ore.

"During the three months the dredge has been working, 20,000 cubic yards have been treated, the cash value of the tin won being about £633 6s. 8d." To the end of 1910 gold and tin to the value of about £1,200 were won.

X.—STANNITE-BEARING LODES.

Stannite, or Stannine.—Described by Dana as occurring "massive, granular, and disseminated. Cleavage indistinct. Fracture uneven, brittle. Hardness 4; specific gravity 4·3 to 4·5; lustre—metallic; streak—blackish; colour—steel-grey to iron-black; the former when pure.

Sometimes a bluish tarnish; often yellowish from presence of chalcopyrite; opaque. Frequently has the appearance of bronze or bell-metal, hence the name bell-metal ore. Composition—sulphur 29·9; tin 27·5; copper 29·5; iron 13·1 = 100.

In closed tube decrepitates and gives a faint sublimate. In the open tube—sulphurous fumes. Before blow-pipe on charcoal—fuses to a globule, which in oxidizing flame gives off sulphur, and coats the charcoal with tin dioxide.

The roasted mineral treated with borax gives reactions for iron and copper.

Decomposed by nitric acid affording a blue solution with separation of sulphur and tin dioxide."

Until its discovery in appreciable quantities at Howell (N.S. Wales) and Zeehan (Tasmania), and more recently at Tolwong (N.S. Wales); this rare ore of tin has not been commercially considered as an ore of that metal.

At Howell it is associated with galena, zinc blende, and mispickel; at Zeehan with pyrite and chalcopyrite, and small percentages of bismuth and antimony sulphides. At Tolwong it is associated chiefly with mispickel, and with chalcopyrite, galena, and zinc blende, in varying proportions.

The constitution of the Stannite-ore at the localities mentioned, is shown in the following tabulated return :—

TABLE showing comparative composition of Conrad, Tolwong, and Oonah Stannites, and Stannite-bearing Ores.

Assay No.	Mine.	Tin (as sulphide).	Tin (as oxide).	Copper.	Iron.	Zinc.	Lead.	Antimony.	Bismuth.	Arsenic.	Sulphur.	Silica.	Lime.	Magnesia.	Carbon dioxide.
....	Conrad Mines, N.S.W...	% 11·8	%	% 15·67	% 22·03	% 5·92	% 10·08	%	%	% 3·14	% 24·82	% 7·00	%	%	% ....
08·3982..	,, ,, ,, ..	26·24	1·40	30·88	11·27	0·54	....	....	....	....	28·44	1·04	....	....	....
....	,, ,, ,,	11·8	....	15·67	22·03	5·92	10·08	...	....	3·14	24·82	7·0	....	....	....
....	,, ,, ,, ..	10·2	....	10·83	23·24	5·45	6·62	....	....	11·42	22·87	8·2	....	....	....
10·3512..	Tolwong Mine N.S.W.	7·47	. ..	11·60	18·34	2·00	....	....	....	16·73	19·09	....	6·62	1·15	4·52
10·3513..	,, ,, ,,	15·73	absent.	19·67	12·18	3·41	....	....	....	6·21	24·12	....	4·26	0·23	3·61
....	Oonah Mine, Tasmania	23·57	0·64	26·77	12·11	0·47	....	0·50	2·27	trace.	32·10	1·40	....	....	....
10·379 ..	,, ,, ,,	6·75	....	12·02	27·44	less than 0·2	absent.	absent.	1·89	trace.	33·51	....	....	....	....

Assay No.	Mine.	Oxygen (by difference).	Gold, per ton.	Silver, per ton.	Analyst.	Reference.	Remarks.
....	Conrad Mines, N.S.W...	%	....	oz. dwt. gr.	H. Condor	Austr. Mining Standard, 18th November, 1908.	.....
08·3982..	,, ,, ,, ..	....	a trace.	111 1 11	J. C. H. Mingaye ..	.....	Picked samples of stannite.
....	,, ,, ,, ..	....	....	(0·34 per cent.)	P. J. Thibault	Metallurgy of Tin, Melbourne, 1908.	Concentrates.
....	,, ,, ,, ..	....	....	(0·28 per cent.)	P. J. Thibault		
10·3512..	Tolwong Mine, N.S.W.	3·86	a trace.	2 3 13	W. A. Greig	Dept. of Mines Assay Records ..	Average sample from No. 6 section.
10·3513..	,, ,, ,,	4·13	....	.....	H. P. White	,, ,, ,, ..	Moisture at 100° C. = 0·22%. Sulphur trioxide, a trace. Picked sample of stannite.
....	Oonah Mine, Tasmania	0·14	....	94 14 13	J. H. Levings.....	Prog. Min. Industry, Tas., Quarter ending 31st March, 1907.	Picked sample of stannite (silver, 0·29%).
10·379 ..	,, ,, , ..	....	....	44 0 8	W. A. Greig	Dept. of Mines (N.S.W.) Assay Records.	Cadmium and tungstic acid—absent.

Conradite.—Discovered by P. J. Thibault, F.C.S. in the Conrad Mines. he following notes are extracted from his description of the mineral :—

"Conradite can hardly be termed an 'ore of tin,' as it has not yet been found in masses, nor has it even been discovered in the free state.

"It is, however, closely associated with the unique stannite deposits of Howell (formerly Bora Creek), New South Wales. In fact, so closely is it associated with the stannite ores, that it really forms one of their constituents, and it cannot be isolated by mechanical, but only by chemical means.

"Its importance as a native stanniferous compound can be understood, when it is stated that, at the time of its discovery by the author (1902), the stannite concentrates produced at the Conrad Mines, at Howell, contained on an average 9 per cent of tin, 3 per cent. of which was carried by the Conradite present.

"The composition of Conradite is expressed in the formula $7\ Sn\ O_2 + Fe_2\ O_3$, being a compound of stannic and ferric oxides containing, tin, 68·44 per cent.; iron, 9·2 per cent.; oxygen, 22·34 per cent.; total, 99·98.

"Conradite is absolutely insoluble in nitric, hydrochloric, sulphuric, and hydrofluoric acids, and *aqua regia.*

"Fusion with caustic and carbonated alkalies at all temperatures has no effect thereon.

"Fusion with alkaline sulphides (sodium sulphide, liver of sulphur, etc.) does not decompose it, although it appears to be more or less decomposed by fusion with a mixture of sodium sulphate and excess of charcoal in presence of other sulphides,

"Fused with bi-sulphate of potash, it remains unaffected, nor is it by this means rendered decomposable by acids.

"Fusion with cyanide of potassium, however, reduces the compound to globules of metallic tin, and a spongy mass of metallic iron. By this means it may be got into solution in hydrochloric acid or *aqua regia*, and to the author's knowledge this is the only means available at at present to decompose this refractory compound.

"Conradite may be isolated from ores and mill products by repeated treatments with acids and other reagents to remove all soluble matters. After this, the insoluble residue is fused repeatedly with excess of caustic soda in a nickel, silver, or platinum capsule, to remove cassiterite and silica, the melt resulting from each fusion being taken up with dilute hydrochloric acid. This is repeated until every trace of silica is removed, after which the insoluble Conradite is filtered off.

"To the naked eye Conradite has somewhat the appearance of red oxide of mercury. Examined under a strong glass it resembles extremely fine garnets. Its specific gravity is approximately 6·2. It is non-magnetic." *

The difficulty of reducing Conradite is reported to have lead to a good deal f difference in determining the tin contents by ordinary assay methods.

Conrad Consolidated Mines, Limited (formerly Borah Creek), Howell, 'arish Mayo, County Hardinge.

* Metallurgy of Tin, 1903, pp. 27, 28.

This persistent lode, both vertically and horizontally, was opened in 189(as a silver-lead proposition, but in time developed copper and tin in addition The latter occurs in the form of Stannite (sulphide of tin) and to a lesse extent as Conradite, also a sulphide of tin.

The two principal mines were the Conrad, and King Conrad, which were subsequently amalgamated under the above title.

The progress of development is illustrated in the following extracts from the Annual Reports of the Department of Mines for the years quoted :—

In 1901 the Conrad Mine produced 13,000 tons of ore, which yielded 3,25(tons of lead, copper, and tin concentrates, realising £26,572. No allowanc being made for the value of the tin concentrates in the form of sulphide.

In 1902 operations were retarded by the great difficulty experienced i treating such complex ores. A small experimental furnace was erected. an run for some time on silver-lead-copper-tin concentrates, produced from th stannite ore. On completion of the tests it was decided to erect tw smelters.

In 1903 4,328 tons of crude ore were raised whilst mining was in progress the average assay value of which was stated to be silver, 18 oz. per ton lead, 7·5 per cent.; copper, 2 per cent.; tin, 2 per cent.

Concentration produced two products, viz., copper-tin concentrates, whic were smelted at the mine, the matte being shipped to Europe ; and silve lead concentrates, which were disposed of to local Customs Smelting Work

In 1904 the Conrad Consolidated Mines were taken over by a Londo syndicate on a twelvemonths' option. In 1905 the lode in the Conra section had been opened to the 420-feet level, and driven on 2,970 fe during the year. The concentrating plant ran for eleven weeks, producir marketable silver-lead concentrates, the copper-tin concentrates being stacke for future treatment.

In 1906 satisfactory progress was made by the Conrad Mines, Limite development extended, concentrating plant re-arranged and enlarge Towards end of year blast furnaces for production of copper matte put in commission ; large quantities of copper-tin concentrates stacked.

9,692 tons of ore were raised, of an average assay value of—Silver, oz. per ton ; lead, 9 per cent. ; copper, 1·2 per cent. ; tin, 0·8 per cent.

During 1907, 38,000 tons of ore were raised of an assay value of—Silv 18 oz. per ton ; lead, 8 per cent. ; zinc, 6 per cent. ; copper, 2·0 per cen tin not mentioned.

In 1908, 22,427 tons of ore raised ; 18,522 tons milled yielded :—

301 tons prill ore, assay value : Silver, 118·2 oz. per ton ; lead, 58·6 per cent copper, 1·0 per cent.
1,812 tons silver lead concentrates, assay value : Silver, 81 oz. per ton ; lead, 44 per cent. ; copper, 0·8 per cent.
337 tons copper-lead matte, assay value : Silver, 351 per ton ; lead, 36·6 per cen copper, 26·6 per cent.
0·85 tons tin-lead bullion, assay value : Silver, 456·4 oz. per ton; lead, 77·0 per cen
57·0 tons oxide of arsenic (crude), assay value : 70 per cent.

During 1909 the mines were idle for ten months. In October they we taken over by a new company, the Conrad Mines, Limited, which treat 1,200 tons of ore for silver-lead concentrates.

The plant consists of :—

Crushing—Gates rock breakers, and May rolls. Concentrating—M jiggs, Wilfley tables, and Frue vanners. Smelting—Blast furnac reverberatory calciner, Merton calciner, reverberatory reduci furnace, matte roasting furnace, liquating furnace.

Mr. B. C. Besley, under date October 7th, 1910, states that :—

"All the ore in this mine that contains copper is a stannite ore, as it also contains tin, silver, and iron. Most of our rich stannite is got in shoots; one shoot, in particular, carrying as high as 15 per cent. of tin. There is about 100 feet of a shoot here, which does not contain less than 2 per cent of tin in any part of it.

"In our bottom level, which is about 700 feet from the surface, there is a very rich shoot of stannite, and the sump-hole, which is 10 feet below the level, is sunk in a stannite shoot, and a special sample taken from the bottom went 12·4 per cent. of tin.

"Since we started operations at Christmas time we have been putting the whole of the tin into the slag, and saving the slag until there is a sufficiently large quantity on hand to put a furnace up to treat it. Several German firms have written us asking for our lowest prices for this product, but we have not sold any up to the present. There are a few hundred tons here which will go as high as 6 per cent. of tin, but most of it will only go 4 per cent."

The Conrad lodes have been studied by L. A. Cotton, who states that they occur in a tongue of "acid granite," at no great distance from its contact intrusion into the "Tingha granite."* The lode constituents are described as arsenopyrite, pyrite, sphalerite, chalcopyrite, and quartz. The average tin contents being about 0·5 per cent.†

Stannite Lodes, Oonah and Zeehan-Queen Mines, Zeehan, Tasmania.

The Zeehan stannite lodes, like the Tolwong, occur in sedimentary rocks at some little distance (5 miles) from the contact of granite. The geology of the locality has recently been described by W. H. Twelvetrees, Government Geologist, and L. K. Ward, B.A., B.E., Assistant Government Geologist, in a joint Report "The Ore-bodies of the Zeehan Field,‡" from which the following notes are extracted, the provisional classification of the sedimentaries being :—

*System.	Representative Formations.
Permo—Carboniferous (?)	9. Glacial till.
Silurian	8. Pale and dark coloured slates and sandstones.
.....	7. Sandstone, pebbly grit, and greenish gray slate.
....	6. Limestone.
.....	5. Shale and slate.
Undetermined (Ordovician ?)	4. Sandstone and slates of the Nubeena and Queen Hills.
Cambro-Ordovician	3. Tuffs, breccias, spilitic lava flows, slates, and sandstones.
Cambrian	2. Tubicolar sandstone.
.....	1. West Coast Range conglomerate series.

"The slates and sandstones and the associated spilite lavas and the tuffs are situated on the northern and north-western side of the other group [of slates.—J.E.C.], and are best seen in association in the area area occupied by the Zeehan–Queen, Oonah, Zeehan–Montana, and Zeehan–Western leases."

* Proc. Linn. Soc. N. S. Wales, 1910, XXXV, p. 499. † *Op. cit.*, p. 505.
‡ Geol. Surv. Tasmania, Bulletin 8, 1910.

Several types of ore are described under Economic Geology, the special types concerned in this section being designated :—

"(2.) *The Stannite-bearing Types.*—The Stannite-bearing types are not easily separated into natural subdivisions, yet there are three modes of occurrence which appear to be, in the light of present developmental work, quite distinct as far as the main mass of each ore-body is concerned. Two of these occurrences contain the same three minerals, viz., pyrite, stannite, and chalcopyrite, but in very different proportions, and therefore fall naturally into one group, which is divided into a high-grade and a low-grade type.

"(i.) *Pyrite-Stannite-Chalcopyrite Type.*—High-grade ore. The vein matter here classified is that which is being mined and smelted by the Oonah Company.

"The principal metallic minerals present in the ore are pyrite, stannite, and chalcopyrite. With these occur also smaller amounts of bismuthinite, tetrahedrite, wolframite, galena, and antimonial lead ores.

"The gangue minerals are quartz and siderite, with occasional bunches of fluorite.

"From the analysis made of picked stannite by Mr. J. H. Levings, it appears that there is a small cassiterite content, and that as much as 15 per cent. of the total tin contents occur as oxide in some cases.

"Mr. Levings' analysis also shows the presence of a little zinc—probably as zinc-blende; but the mineral is not visible in the great bulk of the ore. The proportions in which the principal constituents are present may be seen from the following percentage composition of the ore mined at the present time. The figures have been supplied by Mr. C. H. Stewart, consulting engineer to the Company.

Bulk Analysis of Oonah Ore, as mined.

Silver	22 oz. per ton.
Copper	5·5 per cent.
Tin	4·5 ,,
Bismuth	0·4 to 0·5 per cent.
Iron	26 to 27 ,,
Sulphur	29·0 ,,
Silica	22 to 27 ,,
Alumina	4 to 5 ,,

"The lode contents vary considerably from point to point along the course of the lode. The constituents are frequently arranged in distinct bands parallel to the walls.

"*Low-grade Ore.*—This ore consists almost wholly of pyrite and quartz, with which are a small percentage of chalcopyrite and probably stannite.

"(ii.) *The Pyrite–Stannite–Galena Type.*—The vein-matter here described is that of 'Clark's lode,' on the Zeehan–Queen property. It consists of an admixture of pyrite, stannite, and galena, with little else in addition. A small propostion of quartz is present as a gangue, but quite inconsiderable. The mineral are arranged either in bands or irregular bunches.*

"Stannite has been won from the pyrite-stannite-chalcopyrite (high grade) and the pyrite-stannite-galena veins. Pyrites for the manufacture of sulphuric has for some time past been regularly exported from Mr. Bruce's tribute on the low-grade pyrite-stannite-chalcopyrite ore of the Oonah Mine.†

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* *Op. cit.*, pp. 52–54. † *Op. cit.*, p. 71.

"The Stannite ores have been worked in the past mainly for their silver and copper contents, but the recent successful smelting of the pyrite-stannite-chalcopyrite ore by the Oonah Company has rendered this type of vein-matter of immeasurably greater importance than hitherto.*

"A rather uncommon phenomenon in lode-structure is that displayed by the stannite lode on the Oonah, which consists in places of a series of overlapping narrow lenses arranged *en échelon*, so that the whole lode is built up of alternating bands of vein-matter and country-rock. This probably results from the fissuring in the slate rock, which is readily split. Instead of a single fissure on any one level, a number of apparently separated small fissures have resulted, the strike of which crosses the general direction of fissuring at a small angle.†

"It is interesting to note that the authorities quoted found that the Zeehan ore-bodies 'penetrate rocks older than the granite, and the granite itself'; and concluded that the 'period of formation of the Zeehan ores followed immediately after the period of consolidation of the granite.‡

"Of the Oonah Mine, it is recorded that 'this mine has passed through many vicissitudes, being alternately worked by company and tributors, earning profits and dividends, and at one time heading the list of producing mines in Zeehan. It has, however, suffered from lack of developmental work, though a good deal of work has been done on the galena lode course. The present owners are exploiting the stannite ore deposits of this mine, treating the ore in their smelting works at the south end of Zeehan.

"The main features of the mine are the two lodes known as the galena lode and the stannite lode. These are roughly parallel, coursing north and south, and dipping east. Both lodes in a northerly direction are deviated by a slide which strikes N. 75° W., and dips in an easterly direction. On approaching this slide the lodes bend round to about 30° west of north. The stannite lode emerges on the northern side further west; but the galena lode has not been seen."

"The stannite lode furnishes the mineral for which the mine is being worked. This is an argentiferous tin-copper sulphide, which used to be hand-picked to a product selling for 10 to 13 per cent. copper, and 50 to 80 oz. silver per ton. The tin was not paid for, but eventually the buyers made a small allowance in certain cases. At present under the management of Messrs. Alex. Hill and Stewart, and Mr. Alabaster, the lode is being developed, and two forms of product, viz., a copper-silver matte and a copper-tin alloy, obtained by a metallurgical treatment, the details of which are not available for public information.

"The lode is a banded one, with well-defined bands of stannite, pyrite, and chalcopyrite. A fair quantity of quartz is present.§

"An unexpected discovery on the Oonah property has been that of a small lode of cassiterite in the hill east of the gully near the mine. It runs west into the hill and dips north. Black slate encases the lode, but the country-rock of the hill is white sandstone.‖

"*Clark's Lode on Zeehan-Queen Lease.*—This lode is described as a 'composite one of banded galena and stannite, with a little chalcopyrite, in which stannite has hitherto been neglected, no allowance being made for it in purchasing. The silver yield of the ore sold used to be 70 ozs. per ton. A picked sample of the stannite are from the lode, assayed in the Oonah Mine laboratory, contained 8·5 per cent. tin, 6 per cent. lead,

* *Op. cit.*, p. 72. † *Op. cit.*, p. 88. ‡ *Op cit.*, pp. 98, 99. § *Op. cit.*, pp. 127–129.
‖ *Op. cit.*, p. 131.

and 57 oz. of silver per ton, 8·9 per cent. copper, and 7 per cent. silica. Mr. T. Vincent, junior, former manager of the Silver Queen property, furnished us with assay contents of 20 tons of stannite ore from this lode, viz., copper, 16 per cent.; tin, 14 per cent.; silver, 78 oz. per ton.*

"The Oonah Mine owners are meeting with success in the development of this stannite lode, which has been worked down to 436 feet from the surface. The lode is strong and satisfactory down to the bottom level, and shows every sign of persistence."†

Nowra Division (New South Wales).

The following description of the Tolwong Mine was published after a brief inspection in July, 1908‡ :—

"*Tolwong Mine*, M.L. 1 to 4, Parish Borimbodal, County St. Vincent.—Discovered by John Sivewright about 1904, in a precipitous gorge of the Shoalhaven River Valley, about 9 miles S.S.E. of Marulan Railway Station. The river channel has been excavated from 1,500 to 1,600 feet deep in quartzites and slates of Ordovician age, at least in part. The Tolwong lode is strong and well-defined, cutting across the stratification. The ores are a complex mixture of mispickel, stannine, chalcopyrite, and galena.

"The Tolwong lode varies from a few inches to over 8 feet in thickness, and dips apparently S. 65° W. at 30°. Where it traverses rigid quartzite strata it makes strongest, the pinches naturally occurring in the more yielding slates.

"It outcrops on both sides of a precipitous gorge which has dissected it roughly in the direction of the dip.

"By three tunnels, from 27 to 57 feet in length, and numerous shallow cuts, the lode has been exposed for a length of 2,283 feet. The highest opening above the Shoalhaven River is 770 feet, the lowest about 220 feet.

"The principal lode material, where it makes solid, appears to be mispickel (arsenide of iron), but the unexpected presence of tin sulphide (stannine) in the 37 feet tunnel at No. 6 opening renders further examination throughout necessary for determination of that mineral in other portions of the lode. The copper had previously been determined in the ore from this opening, but not the tin, until the Writer submitted an average sample to the departmental laboratory, when its presence was detected and the amount determined.

"The presence of tin ore in sedimentary rocks at Tolwong at some distance from granite is of interest. It is probable that felsitic contemporaneous rocks may be included in the former which have not yet been carefully examined.

"Fluor-spar, in rich emerald-green masses, also occurs at intervals.

"Galena and zinc-blende are present in parts of the lode, but the aggregate proportion is small, especially the zinc-blende.

"An average sample of the best copper ore from all openings, including the stannine, yielded :—

No. 08-2592—Copper	.....	10·23 per cent.
Tin	.....	2·10 ,,
Arsenic	.....	8·78 ,,
Gold	.....	a few grains per ton.
Silver	.....	2 oz. 15 dwt. 13 grs. per ton.

"This sample consisted chiefly of ore showing chalcopyrite.

* Geol. Surv., Tasmania, Bulletin 8, 1910, pp. 133, 134. † *Op. cit.* p. 158. ‡ J. E. Carne. Mineral Resources, No. 6, 1908, pp. 367, 413, 414.

W. Bennett.

The "Block-Up," Shoalhaven River Gorge, near Tolwong Mine.

W. Bennett.

"An average sample selected from all openings yielded :—

No. 08-2593—Copper	.....	6·12 per cent.
Tin	.....	2·30 ,,
Arsenic	.....	15·80 ,,
Gold	.....	a trace.
Silver	.....	2 oz. 9 dwt. 0 gr. per ton.

"A sample carefully averaged from a considerable quantity broken from a 7 foot face in the 37 feet tunnel at No. 6 opening, and from the stack of mineral raised in driving it, yielded :—

No. 08-2594—Metallic copper	.....	14·13 per cent.
,, tin	.....	10·26 ,,
,, arsenic	.....	0·96 ,,
Gold	.....	a few grains per ton.
Silver	.....	1 oz. 8 dwt. 7 gr. per ton.

"Tolwong mining is only in the initial stage of preliminary development with a view of determining method of treatment, &c. Hitherto arsenic has been regarded as the primary product to be recovered in form of commercial oxide in preliminary roasting, and doubtless, from this strong and permanent lode, it can be obtained in quantity. The presence of both copper and tin as residual products after expulsion of the highly deleterious associate, arsenic, gives a higher value to the ore, though its metallurgy will be complex and difficult.

"Careful preliminary classification may result in the copper-tin ore being kept fairly free from arsenic.

"It is desirable that further prospecting, and careful assay tests, be carried out for the purpose of locating the stannine makes in the lode, and ascertaining their prospective proportions."

A more extended examination was made by the Writer in October, 1910, when a number of samples were selected for assay and analysis. It was noted that the further prospecting and testing recommended in July, 1908, had not preceded, or, at least, kept pace, with surface expenditure. In view of the complex and hitherto unsolved problem of stannite metallurgy, it was perhaps unwise to model a smelting plant on the slender evidence afforded by the experimental efforts of the Oonah Proprietary, on somewhat similar ore at Zeehan, Tasmania. Efforts that resulted finally in practical abandonment of previous metallurgical methods, and adoption of ordinary blast furnace matteing of the contained copper and silver contents of the ore, and discarding of the tin into the slag.

As, however, the Tolwong Mineral Company, Limited, aims at recovering arsenic, in the form of commercial arsenious oxide, a roasting, or oxidizing, furnace is a necessary adjunct, as well as a safeguard for purity of the copper matte, for iron and arsenic have strong affinities, and are with difficulty finally separated.

The grade of the copper matte will be a vital question at Tolwong, because in the light of present knowledge, it will be the only recoverable metallic product the gold and silver contents being unlikely to reach commercial limits.

The highest grade ore—determined by constant assaying—may command a more favourable market as regards contents than the smelted product, hence sale or treatment is a commercial question. The Oonah experience, so far, being—that a metallic alloy of copper-tin-silver, obtained by pot-roasting and blast furnace smelting, is saleable only as tin and silver, or copper and silver; doubtless, also, subject to serious deductions for the combination, though this is not ascertainable.

These factors determined the latest method, viz., matteing the copper and silver and slagging the tin, a method also adopted at the Conrad Mines at Howell.

The Oonah ore consists essentially of copper and iron pyrites in quartz and slate, with stannite equivalent to about 2 per cent. of metallic tin.

The accompanying section, showing the outcrop of the lode channel on the south side of Tolwong Gorge, between No. 1 and No. 6 (a) openings, reveals strong transverse fissuring of folded Ordovician strata, which indicates persistence to great depths in the direction of dip.

Pinching, or closing of the fissure walls at intervals, both vertically and horizontally, limited ore deposition to lens-shaped cavities; hence the necessity for advanced prospecting ahead of stoping to determine the extent of the closed or blank spaces.

The Ordovician rocks consist of quartzites and slates; beautifully arched anticlines are a feature of the former, whose superior resistance has determined sudden drops or falls in the stream bed.

Synclinal folds, on the other hand, have determined small lateral gullies falling into Tolwong Gorge.

A bed of carbonaceous slate in the series, a little north of Tolwong Extended Mine, is characterised by abundant graptolites, amongst which the following forms have been determined by T. S. Hall, M.A., D.Sc., as:—

Dicellograptus elegans, Carruthers.
,, *sp.*
Dicranograptus Nicholsoni, Hopkinson.
,, *hians*, T. S. Hall, var. *apertus*, nov.
,, *c.f. cyathiformis*, Elles and Wood.
,, *sp.*
Diplograptus carnei, T. S. Hall.
,, *foliaceus*, Murchison.
Climacograptus bicornis, J. Hall.
,, *sp.*
Cryptograptus tricornis, Carruthers.
Glossograptus quadrimucronatus, J. Hall.

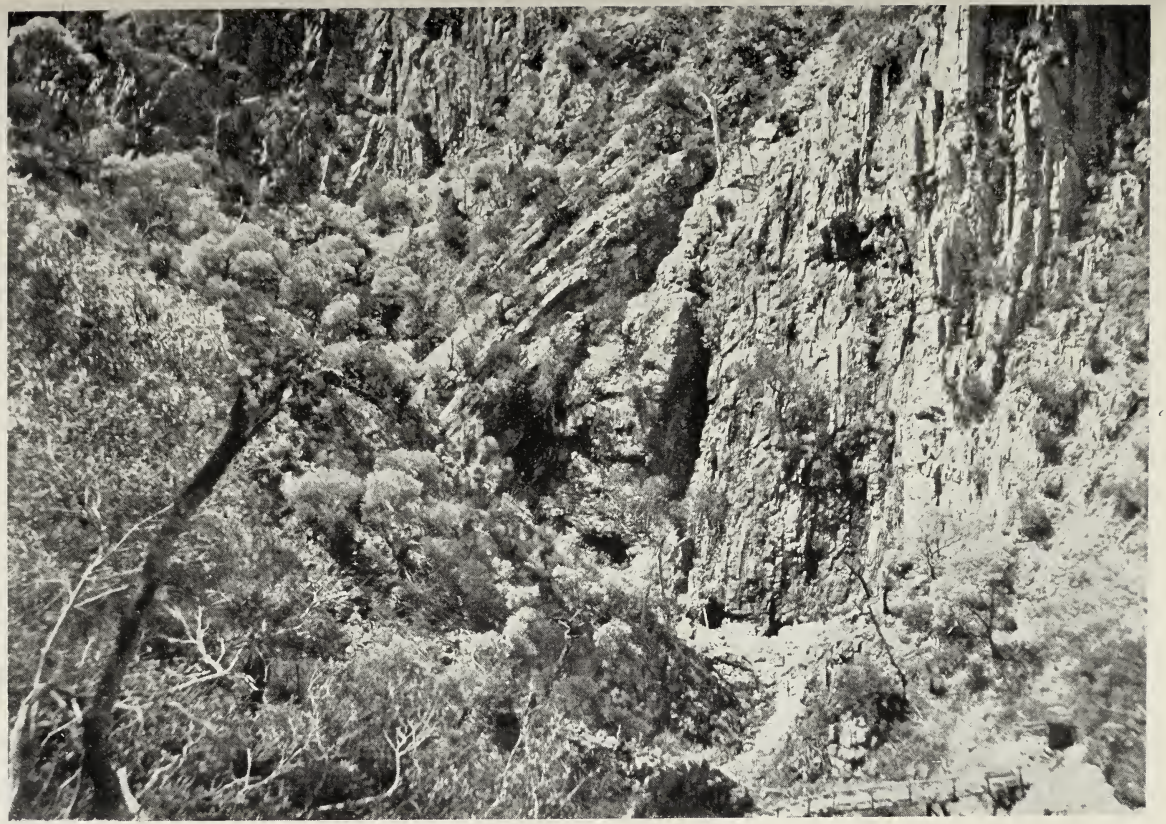
Three dolerite masses are exposed in Tolwong Gorge, between No. 1 workings and the Shoalhaven River, two of which are represented in the section. Two are intrusive, the other appears to be bedded with the strata, but may be intrusive.

These rocks have been examined petrologically by G. W. Card, and described as follows:—

"[**8135**]. Tolwong Block Up.
"[**8136**]. Tolwong Extended (M.L. 6).
"[**8140**]. No. 3 Dyke.
"Also [**8134**] and [**8137**].
} "Ophitic dolerite.

"These are greenish gray, doleritic rocks, the prevailing colour being due to the spread of pigment material to the felspars. 8137 is porphyritic, showing occasional phenocrysts of greenish white felspar. It also shows pyrites.

"Under the microscope, the felspar is seen to be fresh, with the exception of the phenocrysts in 8137, which are clouded, or in part replaced by a talc-like material, as in 8135. It is pervaded by a crystalline green material. Augite is pale in colour, and more or less clouded, or completely altered to green products (8137 shows definite chlorite as the alteration product).



W. Bennett.

No. 6 Section, Tolwong Mine.

"Iron ores are rather conspicuous, and show the titaniferous substance known as leucoxene.

"[1388]. Dyke No. 1. } "Orthoclase-bearing dolerite.
"[8139]. Dyke No. 2. }

"These differ from the foregoing dolerites in not being ophitic, and in containing considerable orthoclase in addition to plagioclase. A little quartz is also present. Augite and titaniferous iron ores are similar to the corresponding minerals in the other specimens."

For the purpose of ascertaining values of first-grade ore at the different provings, a number of carefully selected average samples were taken for laboratory treatment:—

"[3512]. Tolwong mine—'Firsts' (average) from two tunnels in No. 6 section (special test sample), consisting of mispickel, stannite, and chalcopyrite, with a little calcite and fluorspar."

Analysis by W. A. Greig.

Copper	11·60	per cent.
Tin	7·47	,,
Iron	18·34	,,
Zinc	2·00	,,
Arsenic	16·73	,,
Sulphur	19·09	,,
Carbon dioxide	4·52	,,
Lime	6·62	,,
Magnesia	1·15	,,
Insoluble in acids (gangue)*	8·62	,,
Oxygen (by diff)	3·86	,,
	100·00	,,

"Fine silver at the rate of 2 oz. 3 dwt. 13 gr. per ton; fine gold at the rate of a trace (under 1 dwt. per ton)."

To ascertain the composition of the stannite, a small sample was picked as cleanly as possible in minute fragments from the ore, which gave the following analysis:—

[3513]. Tolwong Mine, No. 6 section. "Stannite."

Analysis by H. P. White.

Moisture at 100° C.	0·22	per cent.
Copper	19·67	,,
Tin	15·73	,,
Iron	12·18	,,
Zinc	3·41	,,
Arsenic	6 21	,,
Sulphur	24·12	,,
Sulphur trioxide	trace	,,
Carbon dioxide	3·61	,,
Lime	4·26	,,
Magnesia	0·23	,,
Insoluble in acids (gangue)*	6·23	,,
Oxygen (by diff)	4·13	,,
	100·00	,,

(The absence of Cassiterite proved).

* Composition of gangue =	3512.	3513.
Silica	4·34	2·12
Alumina and ferric oxide	2·40	3·72
Lime	1·30	0·39
Alkali and magnesia	0·58	
	8·62	6·23

"As the composition falls so much below that of pure stannite, viz.—tin, 27·5; copper, 29·5; sulphur, 29·9; iron, 13·1=100; it is evident that it was impossible to completely separate the Tolwong mineral from its associates."

Other selected samples from the Tolwong and Tolwong North Extended lodes were also tested with the following results :—

"**[3510]**. Tolwong Mine, "firsts" from lowest tunnel on north side of gorge.

"**[4511]**. Tolwong Mine, open cut on North side of gorge above No. 6 section.

"**[3514]**. Tolwong North Extended, 'firsts' from No. 2 outcrop.

"**[3515]**. Tolwong North Extended, 'firsts' from tunnel on Shoalhaven River bank.

"**[3516]**. Tolwong North Extended, 'firsts,' No. 3 outcrop.

"**[3517]**. Tolwong North Extended.

No.	Gold.	Silver.	Tin.	Copper.	Arsenic.
		oz. dwt. gr.			
3510	A trace..	1 17 0	5·14	8·45.....	16.93
3511	A few gr.	13 18 18	0·66	5·35.....	22·62
3514	Do	1 9 9	1·38	·270...	5·09
3515	1 dwt. 15 gr. .	0 15 9	None detected	Under 0·10	37·93
3516	1 dwt. 15 gr. .	0 1 15	do	None detected... ...	42·49
3517	1 dwt. 15 gr. .	0 1 15	do	Under 0·10	26·28

The following particulars of the Tolwong Plant, under construction, have been supplied by the General Manager :—

"*Roadway.*—A road has been made for a distance of 280 chains, starting from the main road to Bungonia, and then for 3½ miles in an easterly direction, connecting with the winding station of the first section of aerial tramway.

"The greater portion of the road has been cut round the side of the mountain, and is 12 feet in the solid.

"The side cuttings in places are very heavy, the banks being, in some instances, as high as 12 feet.

"In making roads in the side cuttings a good deal of solid rock was met with which required shooting. The most dangerous portion of the road has been fenced (posts and rails) for a distance of 33½ chains, at a cost of 16s. per chain.

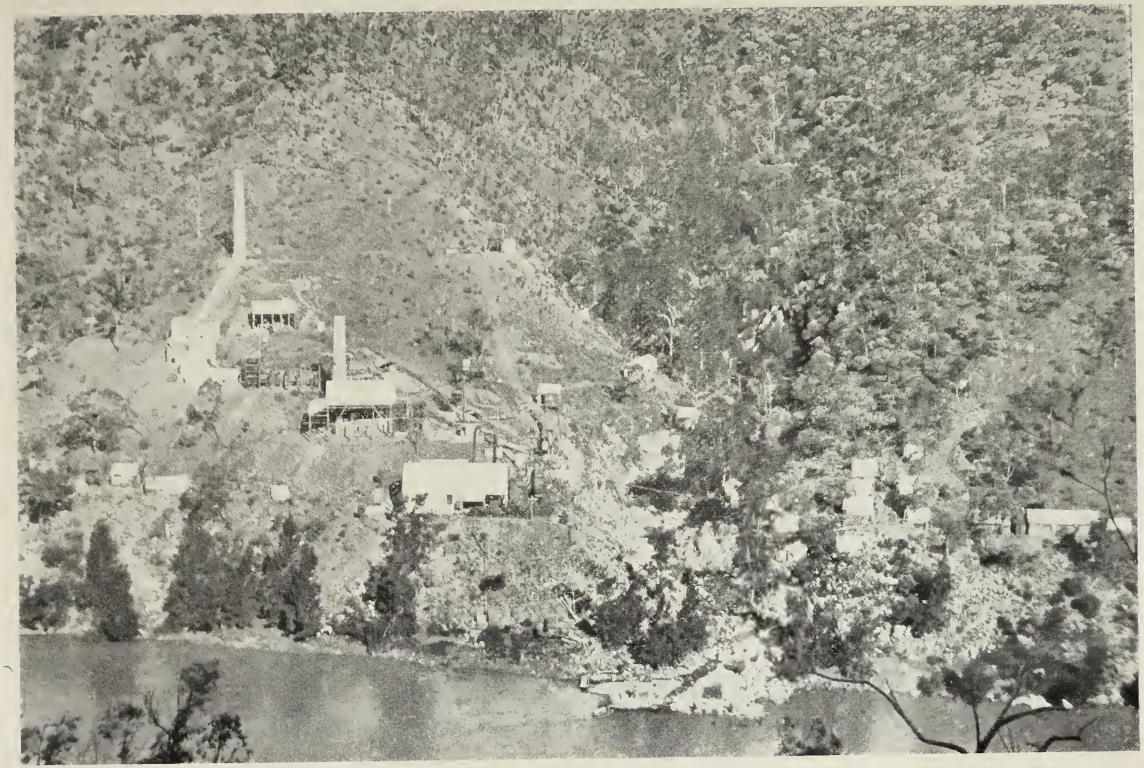
"*Aerial Tramway : First Section.*—The first section of aerial tramway is completed. It starts from the end of road, and thence runs in an easterly direction for 2,700 feet, terminating at machinery site, eastern bank of Shoalhaven River.

"The elevation from despatching station (machinery site) to unloading station, on top of mountain, is 1,134 feet.

"The grade up face of mountain is 1 foot in 1½ feet.

"The grade from despatching station to No. 3 trestle is 1 foot in 2 feet (grade of fixed ropes), and from No. 3 trestle on to unloading or winding station is a grade of 1 foot in 5 feet.

"The first section of aerial tramway consists of two fixed ropes (steel wire) of 3¼ in. circumference. Each rope is 2,700 feet in length; they are securely anchored each end in solid concrete, 12 feet deep by 9 feet



W. Bennett.

Tolwong Smelting Plant, Shoalhaven River.

in length, and 5 feet in width. The fixed ropes pass over top trestle (braking station), to which are attached the two brake wheels, and are then supported by three supporting trestles, each built of hardwood and Oregon; the timbers are 12 inch x 12 inch, 12 inch x 8 inch, &c.

"The trestles stand 24 feet in height.

"The loading station is situated on the machinery site, 56 feet above river level.

"The greatest span is 1,700 feet in length.

"The buckets are hauled backwards and forwards by means of a hauling rope, which is fastened to each bucket.

"Total length of hauling rope is 5,500 feet, $1\frac{1}{4}$ inch circumference, and a breaking strain of $5\frac{1}{2}$ tons.

"The breaking strain of the fixed ropes is about 24 tons, the slack of which at any time can be taken up by means of a 24-ton winch, which is securely fastened down on to the framing of the loading station.

"A 25-brake h.-p. electric motor is in course of erection on the top end of tramway (unloading station), which will work up to 35 b.h.-p. for a period of thirty minutes, which will give ample power for hauling up loads of from 10 to 20 cwt. at the rate of between 6 and 8 miles per hour.

"A good deal of machinery, timber, and other materials have already been sent down the mountain on the aerial tramway.

"Some loads as heavy as 1 ton and $1\frac{1}{2}$ tons (these could not be lightened—they were the low and high-pressure cylinders of the engine) have been sent down on the tramway, and all other loads have not exceeded 16 to 18 cwt.

"The tramway works splendidly, the full bucket bringing up the empty one.

"*Aerial Tramway: Second Section.*—The second section of the aerial tramway is similar in construction to No. 1 section, with the exception of the fixed and hauling ropes.

"The fixed ropes are $2\frac{3}{4}$ inches in circumference, and are 2,250 feet in length.

"The hauling rope is 4,500 feet in length, and $1\frac{1}{4}$ inches in circumference.

"The breaking strain of fixed ropes is 21 tons 6 cwt., and hauling ropes $2\frac{1}{2}$ tons.

"This section has only one supporting trestle, situated on the crown of a high spur, about 410 feet above bed of the Gorge.

"The despatching station is situated opposite No. 6 workings, and runs thence for 2,250 feet in a westerly direction to the machinery site.

"The winding station is situated just above machinery site on M.L. 5.

"From winding station to supporting trestle on top of spur is a span of 1,520 feet (horizontal length), with a grade of 1 foot in $3\frac{1}{2}$ feet, and a rise of 413 feet.

"The span from supporting trestle to despatching station is 650 feet in length, with a grade of about 1 foot in 10 feet.

"Winding station of this section is 131 feet above river level.

"A 15 brake h.-p. electric winding motor installed on this section of aerial tramway is capable of winding at the rate of between 6 and 8 miles per hour, with loads of between 10 and 20 cwt.

"The plant for generating the electric power for motors for tramway consists of two loco. type boilers, each of about 90 indicated horse-powe one compound surface condensing engine, made by Thompson and Son (Castlemaine), indicated horse-power of which, without condenser, 114 horse-power; with condenser, add 25 per cent.

"The engine, the cylinders of which are high-pressure 10 inc low-pressure 20-inch diameter, and 24-inch stroke. The electr generator will work up to 112 b.h.p. There is ample power in reser when it is required for rock-breakers, compressor, electric hoists, &c., &

"*General.*—Both sections of aerial tramway are connected by telephon

"Crushing plant consists of one May's rock-breaker.

"Capacity, 7 tons per hour; 2-inch slit.

"May Brothers' Rolls, 7 tons per hour.

"Rolls and rock-breaker driven by 25 b.-h.-p. electric motor.

"The ore, after being broken to $\frac{1}{8}$ inch, will go through the Legg roasting furnace. Furnace will treat 200 to 250 tons per week. Th recovery chambers for the arsenic are 12 feet x 12 feet x 12 feet (two About 200 feet flues, and stack 60 feet high. The ore, after roasting, w go to the reverberatory, which will treat from 90 to 100 tons per week

Metallurgy of Stannite-bearing ores.

As regards the commercial treatment of stannite, it is instructive to reco attempts which have been made to separate its constituents, or to produ alloys or mattes commanding full market values for combined metals.

Until the Australian and Tasmanian discoveries the infinitesimal quantiti produced in other tin-producing countries have been commercially disregard as tin ore, and sold—as in Cornwall—as copper ore.

At the Conrad Mines, Howell, New South Wales, magnetic separation stannite from associated sulphides of copper, lead, iron, silver, and arsenic, w attempted with results described by P. J. Thibault as extremely gratifying It should, however, be borne in mind that, in Mr. Besley's opinion, all t copper is combined with tin in the form of stannite; hence, magne separation would only affect the uncombined metallic ores.

Here also the first experimental smeltings of stannite-bearing ores we undertaken. These have been described at length in the above work, fr which the following notes are extracted.†

"The material operated upon consists of concentrates containing values silver, tin, copper, and lead. These are, of course, variable composition, but their composition as shown by the following analy may be taken as being typical examples:—

	Silver.	Lead.	Copper.	Tin	Iron.	Zinc.	Arsenic.	Sulphur.	Silic
1	0·34	10·08	15·67	11·8	22·03	5·92	3·14	24·82	7
2	0·28	6·62	10·83	10·2	23·24	5·45	11·42	22·87	8
3	...	12· 0	6·76	5· 2	...	...	.....	.....	..
4	...	13· 0	6·22	4· 9	....	...	.....	.....	..
5	...	13· 0	2·54	0·61	23 ·0	12·07	6·48	27·13	15

"Concentrates of the grade such as shown by analysis No. 5 a really not suitable for treatment by the process under discussion, owi

* Metallurgy of Tin, 1903, p. 159–162. † *Ibid.*, pp. 198–206.

RKIN

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surfaces of the pieces of matte as possible.

PLAN OF THE TOLWONG MINERAL COMPANY'S WORKINGS, NEAR BUNGONIA

SCALE 0 150 300 600 900 FEET

Taken from Mine Manager's Plans

PARISH OF INVERARY COUNTY OF ARGYLE

PARISH OF BORIMBADAL COUNTY OF ST. VINCENT

ROAD FROM BUNGONIA

ORE DISCHARGE STATION

AERIAL TRAMWAY

SHOALHAVEN RIVER

ML 5

ML 2

ML 8

ML 4

ML 1

ML 7

D WORKINGS

AERIAL TRAMWAY

Bed of Gorge

No. 7

Falls

ORE DESPATCH STATION

No. 8 WORKINGS

No. 6a

No. 6

WORKINGS

No. 5

WORKINGS

Section showing Aerial tramways

Scale 0 400 800 Feet

ORE DISCHARGE STATION

Trestles

AERIAL TRAMWAY

SHOALHAVEN RIVER

SMELTING PLANT

AERIAL TRAMWAY

WORKINGS

Bed of Gorge

1183'

545'

510'

900'

78094

Ordovician slates and quartzites

No. 1

QUARTZITE

SLATE

BANDED QUARTZITE

WORKINGS

No. 2

No. 3

Lode fissure cutting across stratification

ALTERED SANDSTONES AND CLAYSTONES

Falls

No. 4

WORKINGS

No. 5

TUNNEL

No. 6

Ordovician slates and quartzites

Lode fissure cutting across stratification

No. 8 WORKINGS

BANDED QUARTZITE

QUARTZITE WITH SLATE BANDS

INTRUSIVE DYKE CUTTING THROUGH FALLS STRIKE N. 70° E WIDTH 8 FEET

Falls

SLATE WITH QUARTZITE SANDS

East

SECTION ON SOUTH SIDE OF TOLWONG GORGE BETWEEN No. 1 AND No. 6a WORKINGS SHOWING LODE FISSURE CUTTING ACROSS STRATIFICATION

West

SCALE 0 20 40 60 80 FEET

by J. E. Carne, F.G.S., assisted by E. C. Saint-Smith.

LOOKING SOUTH

78094

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

to the fact that the tin contents have to be recovered from, comparatively speaking, a vast body of slag; the cost per unit of tin recovered being thereby materially increased, and the technical result being by no means satisfactory."

"In the Writer's opinion, what is really required for these lower-grade concentrates is a preliminary reconcentration, or, more correctly speaking, separation of the stanniferous sulphides by electro-magnetic means.

"The concentrates on being delivered to the smelting works are charged into an ordinary hand-worked calcining furnace, and there calcined to eliminate arsenic and the greater part of the sulphur, and to oxidise the tin sulphide to oxide."

"The following analyses show the typical grades of calcined concentrates produced in this operation :—

	Lead.	Copper.	Tin.	Iron.	Zinc.	Arsenic.	Sulphur.	Silver.
1	12·0	11·71	11· 0	20·1	11·8	1·3	11·43	17·5
2	10·6	11· 3	9·99	.....	.....	.....	.....	.....
3	14·0	7·34	8·11	.. ...	.....	.....	.....	.....
4	16·0	4·12	3·78	.....	.....	.....	.....	.....

"The calcined concentrates are next mixed with variable quantities of raw slimes, according to the percentage of silica already present, together with drosses of variable composition, and refinery slags from previous operations. The mixture is then charged into a reverberatory furnace fired with wood, and having a capacity of about 6 tons per day."

"This section of the process, excepting for the slagging of the oxidised tin, and the probable reduction of portions of the tin oxide by the action of SO_2, and the matteing thereof is essentially that of ordinary copper matteing.

"The products of the fusion are a matte of from 30 to 40 per cent. copper, and 6 to 8 per cent. tin, and a slag of from 35 to 40 per cent. silica, with from 6 to as high as 14 per cent. tin.

"The typical composition of these mattes are shown by the following analyses :—

	Lead.	Copper.	Tin.	Zinc.	Iron.	Sulphur.	Insoluble.	Silver per ton.
1	21·5	35·8	4·04	9·0	7·03	20·85	0·85	226 oz.
2	20·8	35·8	7·3	6·2	8·0	21·8	.....	209·45 ,,
3	19·95	34·2	7·47	8·0	9·27	21·0	.....	218·5 ,,

"The next stage in the process consists in destannising this coarse matte, as it is termed, and, at the same time, enriching it up to about 60 per cent. copper, this being the most profitable limit. This is effected by subjecting it to what is termed, in copper parlance, 'roasting,' but more correctly stated an 'oxidising fusion.'

"The pigs of coarse matte are broken up into pieces of moderate sizes, and charges of from 2 to 3 tons furnaced. The charge is melted down slowly in order to obtain as great an oxidising effect upon the many surfaces of the pieces of matte as possible.

"After smelting, the slag which has formed is skimmed, and the fusio continued; skimming is repeated until it is judged that the tenor of th matte is about right, that is, 58 to 60 per cent. copper.

"Much of the tin originally contained in the coarse matte so treate enters the slag which derives its silica from the lining and fettling of th furnace. These slags are invariably rich in copper, and on that accour are unsuitable for destannising.

"This was once attempted by Mr. John Howell, formerly Managin Director of the Conrad Mines (N.S.W.), but the result was disastrou The slag operated upon contained about 14 per cent. tin. The bullio produced was of such a coppery character and so refractory that withou the aid of some special method nothing could be done with it in the wa of separating its constituents.

"Its composition is shown in the following analysis:—

Silver	1·382 per cent.
Copper	51·41 ,,
Lead	7·0 ,,
Tin	40·51 ,,

"These slags are, therefore, invariably sent back to the matteir furnace, and retreated in conjunction with calcined ore charges, by whic means they are freed from the excess of their copper contents, withou in any way being depreciated in their combined tin values.

"The 'refined matte,' as it is termed, resulting from this operation never entirely free from tin, nor can it be made so without materiall prolonging the oxidation. Owing to the fact that some complex reactio take place between the sulphides, sulphates, and oxides of copper an lead, such a procedure is not feasible, for when the tenor of the matte increased to about 70 per cent. copper there is an almost instantaneo heavy fall of metallic copper and lead and tin.

"The percentage of tin in the 'refined matte' is shown to range fro 0·7 to 2·5, the average being about 1·2 per cent.

"The refined matte, together with any bullion on the hearth of th furnace is tapped into large matte pots, and there allowed to cool. Th bullion, which of course settles to the bottom, separates into two ver distinct alloys. The lower layer, a hard, leady metal, and the top brittle alloy, essentially of copper and tin, which may easily be groun and sieved like glass.

"The following is a complete analysis of a sample of the latt metal:—

Silver	2·424 per cent. = 804·846 oz. per ton.
Copper	61·9 ,,
Tin	29·07 ,,
Lead	4·5 ,,
Zinc	2·67 ,,
Iron	0·21 ,,

"The leady portion is extremely variable in composition, as may b judged from the partial analysis of three different samples:—

	I.	II.	III.
Silver	.....	2·004	1·74
Lead	63·00	58·0	34·0
Copper	21·06	20·6	46·3
Tin	5·94	12·74	12·99

* *Ibid.*, pp. 198 to 201.

"This metal is liquated in a small reverberatory furnace at a low temperature, and yields a dross containing silver suboxide, and oxide of copper, oxide of, and metallic lead, tin oxide, metallic tin, and probably stannates of lead with various incidental impurities, and a liquated stanniferous silver-lead bullion of variable composition and purity."

"The drosses are returned to the matting furnace, and the liquated bullion further refined by being melted and poled.

"The brittle bullion is subjected to an oxidising fusion, and thus converted into dross, which also goes back to the matteing furnace.*

Mr. Thibault adds:—

"Perhaps the one great fault of the process just described, in so far as the separation of the tin is concerned, is that it is contained in a, comparatively speaking very large bulk of slag. Moreover this bulk increases as the copper contents of the concentrates decrease, and as the proportion of tin is very closely allied to that of copper in the concentrates, so with an increased production of slag there is a relatively proportional reduction in its tin contents.†

The process outlined above may be regarded as unprofitable, for it was ortly abandoned.

The latest method, like that at Oonah, in Tasmania, is to discard the tin, all events for the present. Under date October 7th, 1910, Mr. B. C. Besley ormed the Writer:—

"Since we started operations at Christmas time we have been putting the whole of the tin into the slag, and saving the slag until there is a sufficiently large quantity to hand to put a furnace up to treat it."

Oonah metallurgical experience in regard to stannite-bearing ores is outed in the following notes:—‡

In 1908, a shipment of this ore was despatched to Europe for treatment, an option over the mine depending on the result. The result was evidently unfavourable, as nothing eventuated.

Hartwell Conder, A.R.S.M., states:—

"With regard to the treatment, various methods of concentration have been tried with unsatisfactory results. Concentration after roasting gave no encouragement, the copper and tin appearing to be still allied. Treatment with nitric acid removes the copper and iron, and oxidises the tin, and a certain concentration from the quartz can then be secured, but there seemed little promise of commercial success on these lines.

"Similarly with magnetic separation and flotation methods, the results were discouraging. The fact is that the pyrites as well as the quartz must be considered as gangue, since for useful concentration the tin-copper-silver values must be separated from both of these, and the stannite is so intimately associated with them, especially with the pyrites, that physical methods seem to hold out little hope. Chemical methods offer more promise, and several methods have been tried, based on the solubility of the sulpho-stannates, and on the different conducts of the chlorides of the metals present." . . . . "Smelting is also possible, and by this means the copper and silver values can be readily

* *Ibid.*, pp. 202-203. † *Ibid.*, p. 203. ‡ *Australian Mining Standard*, 7th October, 1908.

secured. The tin is more difficult, but it is possible to slag off the tin from the other metals, and then recover a good proportion of it from these slags."*

According to the *Mining Magazine*,† another shipment was despatched, this time to England, where both smelting and wet methods of treatment were tried, the result being that :—

"Eventually it was found possible, by aid of a roaster and reverberatory, to make two products: (1) a copper-silver matte, and (2) an argentiferous copper-tin alloy. These are marketable, but buyers will not pay for tin in the matte, nor for the silver in the copper-tin alloy."

"The subsequent history of the venture is contained in the report of the company for the year ending June 30th (1909—J.E.C.), and in Alexander Hill and Stewart's report. dated 18th January of this year. A smelting plant was erected near the mine consisting of a roasting furnace [a Leggo—J.E.C.] and a reverberatory, together with a blast furnace for the treatment of the tin slag from the reverberatory. Experience gained by trial runs induced Mr. Stewart, who was in charge of operations, to modify the policy and to treat the ore direct in the blast furnace, using the reverberatory for the refining of the copper-silver matte only. This alteration involved the adoption of pot-roasting. Experiments were, therefore, made at the Mount Lyell and the Tasmanian Smelting Works with gratifying results, the cost of the operation being less than 3s. per ton. The trial runs at the blast furnace showed that bottoms containing from 39 to 49 per cent. tin, 0 to 17 per cent. copper, and about 250 oz. silver,‡ could be produced, together with copper-silver matte, averaging 8·2 per cent. copper, 5 per cent. tin, and 30 oz. silver."

"The blast furnace product also contained from 7 to 19 per cent. bismuth and various amounts of iron. The slag produced contained from 0·1 to 0·2 per cent. copper, and 0·4 to 0·55 per cent. tin. Efforts were made to produce a matte less in quantity but of higher grade, but though this alteration had the advantages of using less flux and producing cleaner slag, it was open to the objection that much tin was lost by volatilization. By adopting pot-roasting it has been possible to eliminate fine crushing and roasting, and the cost of operations has been slightly reduced. It is estimated that 50 tons of ore will be treated per day in the blast furnace, and that the profit should be at least £4,500. Unfortunately the smelter is at present idle owing to the New South Wales coal strike having cut off supplies of fuel."*

In November, 1910, the Writer visited the Oonah Smelting Plant, and found that all attempts to recover the tin contents of the stannite ore had been abandoned (at all events for the present) in favour of ordinary blast furnace production of copper-silver matte.

The bullion produced by pot-roasting and blast furnace smelting is reported to have the following composition ‡:—

Tin	36 to 42 per cent.
Copper	42 to 44 ,,
Bismuth	4 ,,
Antimony	3 ,,
Silver	660 oz. per ton.

* The Occurrence of Stannites in Australasia.—*Australian Mining Standard*, 18th October, 1908.
† II, No. 2, February, 1910, p. 154.
‡ For which £80 per ton was offered (*Daily Telegraph*, Launceston, March 1, 1911).

J. D. Millen.

Mount Bischoff Tin Mine, Tasmania.
(View of benches on south-east slope.)

J. D. Millen.

Mount Bischoff Tin Mine, Tasmania

As only two of these metals were saleable in this alloy—either tin and ver or copper and silver—the extra cost of producing rendered the process ıprofitable.

It was, therefore, found more advantageous to simply smelt direct for pper-silver matte with addition of iron oxide and limestone flux, the furnace arge being in in the following proportions :—

Ore	10
Limestone	4
Iron oxide	4
Coke	4

The matte produced in this semi-pyrite smelting contained about 36 per cent. pper, 4 per cent. tin, and silver at the rate of 157 oz. per ton ; part of the ı being volatilized, and part slagged.

The ore then being furnaced consisted essentially of copper and iron pyrites quartz and slate, averaging about 2 per cent. of metallic tin and 1 per cent. bismuth.

The original process of oxidising in a Leggo roaster, and smelting in a verberatory furnace, is reported to have proved slow and unsatisfactory, ough a 60 per cent. copper product was obtained.

The Ooonah Mine and Smelting Works closed down shortly after spection.

Mt. Bischoff Tin Mine, Tasmania.—This celebrated mine is so well known ıt reference to it alone is necessary. The record of achievement in luction of costs to meet falling ore tenor is, however, worthy of special note. ıly under the favourable conditions of mining (chiefly by quarrying), and eap motive power (water), could profits be won from a metallic recovery of out 0·35 per cent.

The following notes have been supplied by Mr. J. D. Millen, General ınager :—

"The flow sheet herewith is of the Milling and Concentrating Plant at present under erection ; the design of this plant embodying the result of numerous experiments that have been carried out during the past three years.

"The present milling and concentrating plant is treating 19,000 tons of ore per month, containing 0·56 per cent. of tin oxide, and of this about 82 per cent. is saved in concentration.

"The battery is divided into mills adjoining each other, one consisting of 25 head of stamps, and the other of 60 head, making a total of 85 head

"In addition to this there is another large plant in course of erection.

"The great bulk of ore treated comes from the surface workings, but a large amount is won from the underground operations.

"The various workings have many different features of interest owing to the diversified nature of the deposit, some of the tin ore being found in talus deposits, some in soft decomposed porphyry, retaining the original boundaries, some in quartz-porphyry dykes, some in true lodes, and some in reticulating veins forming a kind of stock-work.

"The backbone of the Mount is a large stanniferous porphyry dyke, which at the surface has a varying width of from 15 feet to 150 feet, and a length of over 5,000 feet. The total depth to which it carries payable tin values is unknown. The deepest workings are at the 200 feet level. In addition to this large dyke there are numerous lodes, but by far the most extensive is that known as the Queen Lode. This lode is a true fissure, penetrating through both slate and porphyry Its

width varies from about 18 inches to 18 feet, with an average width c 3 feet. It has been opened for a length of 3,000 feet, and has an averag value of 1½ per cent. tin oxide.

"The following are the details of the present cost of treating a to of ore :—

	s.	d.
Mining, including works, stores, &c.	2	1·248
Filling, hauling, and emptying trucks	0	4·644
Milling and concentrating	0	10·917
Prospecting and developmental work	0	1·528
Electric running	0	0·629
Surveying	0	0·440
Assaying and sampling	0	0·799
Races and dams	0	0·584
Administration	0	2·444
	3	11·213

"The output of tin oxide from the mine since its inception is 69,50 tons, and the amount of dividends paid to the 31st December, 1910, £2,235,000—equal to £186 5s. per share, the capital being 12,00 shares of £5 each."

According to D. Clark, B.C.E.,* tin ore was discovered by James Smit at Mt. Bischoff in 1871 ; mining started 1872, and the present compan formed in 1873.

The Vulcan Tin Mine, Irvinebank, Northern Queensland, is interesting s being the deepest tin mine in Australasia. The following particulars c developments at the lower levels, and the output from 1890, have bee extracted from the thirty-eighth half-yearly report of the Vulcan Tin Minin Company (No Liability), dated 20th August, 1910 :—

"About the middle of the half-year our energies were directed t opening out on a bench of good ore which had been located between th 400 and 500 foot levels. Some 1,360 tons of fair grade ore have bee obtained from this work, and have been sent to the battery ; ther remains a good quantity of the same class of ore still to be broken.

"500-*foot level.*—Good ore was found to be going down from this leve which has been followed to a depth of about 20 feet from the leve producing 80 tons of rich ore. The bottom continues to look well, b we have had to discontinue further work here until the bench of or between the 400 and 500-foot levels has been taken out.

"600-*foot level.*—Western Ore Body.—A small chute of ore was foun going down from this level which produced 75 tons of high-grade or The chute was followed down, but the ore in the bottom at present i rather poor. It is intended to continue work at this point in the hop that the ore will improve in value.

"600-*foot east.*—About 100 tons of good ore was obtained dow 'Donnelly's' winze, and further quantities can still be won, but as th winze is used for a pass for the ore from above, we are compelled to le further work stand for the present.

"750-*foot level.*—A chute of ore was located down No. 1 winze, an proved to be about 12 feet by 7 feet, from this about 310 tons wer obtained. On the ore giving out a drive was put in for 9 feet throug heavy mineralised lode in the hope of locating a further bunch, but th tin contents proved disappointing.

"900-*foot level.*—The good ore mentioned in the last half-yearly repor as being then just met with, and which looked very encouraging at the

* Aust. Mining and Metallurgy, 1904, p. 185.

J. D. Millen.

Mount Bischoff Tin Mine, Tasmania.

("Brown Face.")

MOUNT BISCHOFF TIN MINING COMPANY
TASMANIA
50 HEAD BATTERY AND CONCENTRATION MILL
FLOW SHEET FOR 20 HEAD UNIT

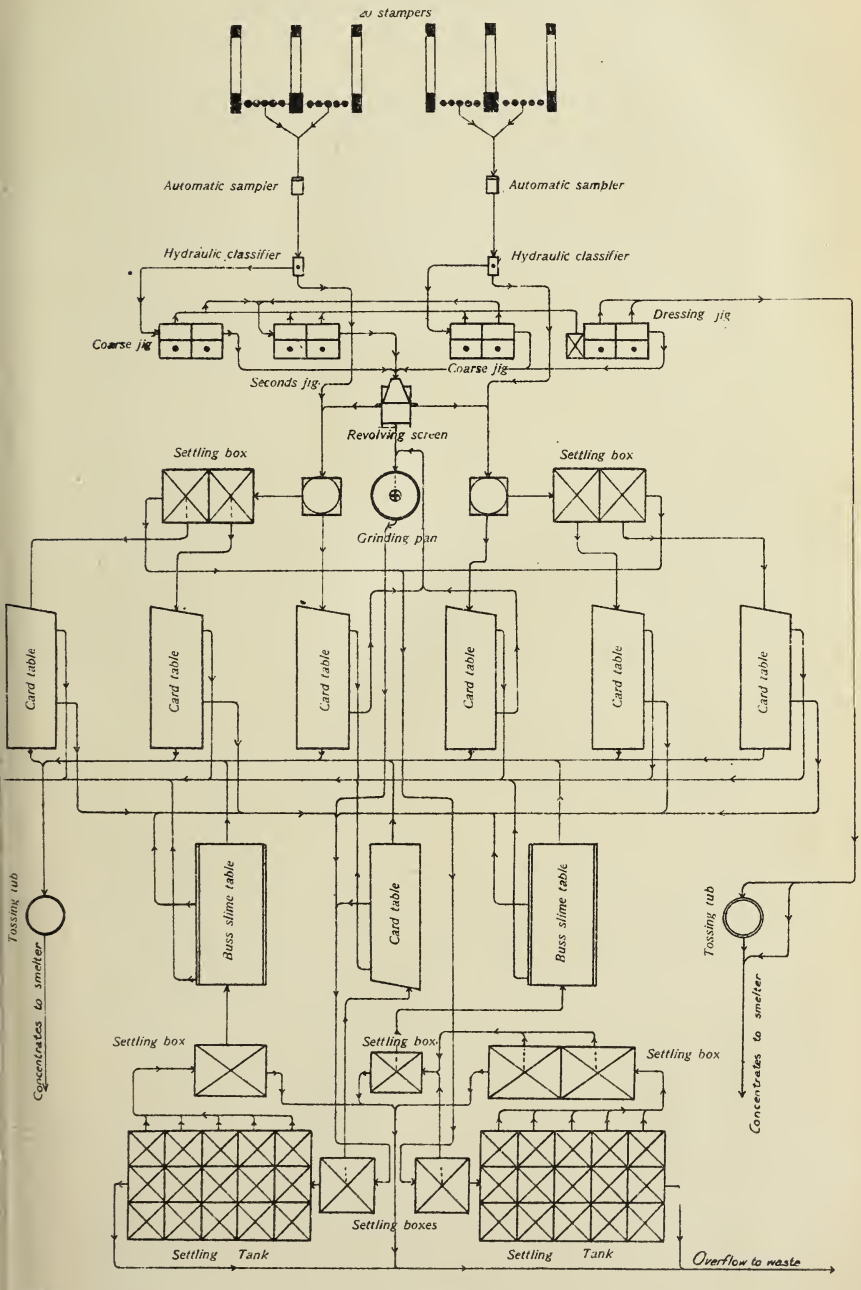

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PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

date, failed to come up to our expectations, the size of the ore body being 10 feet by 3 feet, and although the drive was extended for 51 feet, no ore of any value was met with. A rise was put up a distance of 8 feet and a crosscut 30 feet, all in highly mineralised formation. It is intended to continue this crosscut for some distance further as its extension will prove the ground under the 600 feet western ore body.

"1,050-*foot level.*—During the half-year about 1,680 tons of ore have been broken in the stope from this level. We have worked down to 100 feet, leaving some 70 feet to stope to connect with the 1,220 feet to stope to connect with the 1,220-foot level. It is a matter of regret that this stope has proved so very disappointing; there is a large ore body to work on. Tin values are low. Early in June the directors made special arrangements (for a period of twelve months) with the Irvinebank Mining Company (Limited) for the treatment of all ores obtained from the stope between the 1,050 and 1,220 feet levels. It is pleasing to report that during the past week a decided improvement has taken place between the 1,050 and 1,220 foot, especially to the south, the present trend of the ore body showing that its downward extension would carry the ore south of all existing workings at the 1,220 foot.

"1,220-*foot level.*—A crosscut was put in north-westerly a distance of 98 feet, passing through a mixed formation carrying only patches of tin. Work at this point has been discontinued pending further developments in the downward extension of the ore body from the 1,050-foot level.

"1,400 *foot level.*—The main drive is in a total distance of 210 feet from the plat chamber. At 198 feet in, a lode was met with, which was opened out on for 22 feet by 18 feet., but the tin values were very low and work was discontinued, it being considered advisable to first locate the ore at the 1220-foot level, in the hope that this will throw additional light as to the dip of the lode.

"*Ore treated.*—During the half-year 3,608 tons 5 cwt. of stone were crushed for a yield of 131 tons 6 cwt. and 9 lb. of tin concentrates, which were sold for a gross return of £8,450 15s. 5d."

Statement of Produce from Vulcan Tin Mine since October, 1890.

Date.	Stone crushed.	Concentrates produced.	Gross value.	Dividends.	Duty.
	tons cwt. qr. lb.	tons cwt. qr. lb.	£ s. d.	£	£ s. d.
Totals brought forward	83,912 18 0 0	8,538 8 0 25	356,83 19 1	148,830	6,784 8 9
Six months ending 4th February, 1907	4,184 0 0 0	256 0 0 0	20,527 19 6	13,200	391 6 0
Six months ending 8th August, 1907	3,338 10 0 0	177 10 2 11	13,325 16 2		
Six months ending 19th February, 1908	5,442 10 0 0	264 6 3 1	14,086 11 11		
Six months ending 5th August, 1908	74 5 0 6	303 10 1 20	15,509 13 0		
Six months ending 31st January, 1909	4,129 5 2 0	250 15 0 2	12,989 8 0		
Six months ending 31st July, 1909	2,210 4 3 0	90 7 1 21	4,456 16 10		
Six months ending 14th February, 1910	4,964 12 2 0	218 0 0 13	12,998 10 5		
Six months ending 4th August, 1910	3,608 5 0 0	131 6 0 9	8,450 15 5		
	116,964 10 3 0	*10,230 13 2 18	459,180 10 4	162,030	7,175 14 9

* Equal to 8·7 per cent.—J.E.C.

XI.—OUTLOOK OF THE TIN INDUSTRY IN NEW SOUTH WALES.

An investigation of the stanniferous areas of the State confirms the relatively restricted character of the available sources of tin supply, a fact applying equally strongly to the World's visible tin resources. No new fields of importance await development—at least none are known—though some, like the Bolivian, offer potentialities of expansion under modern methods. Hence it behoves the country possessing tin-bearing lands to husband them for legitimate mining.

Though nothing is known beyond the bare fact of occurrence, it may be well to draw attention to Dr. H. B. Guppy's references to the occurrence of stream tin on St. Christoval and Bougainville Islands in the Solomon Group.*

With the exception of the basalt-covered leads, the stanniferous areas of New South Wales are usually rugged and unfitted for closer settlement. The grazing capacity of such land can be fully developed without interference with mining interests.

Another fact which investigation brings into strong relief is the rapid exhaustion of the easily worked shallow alluvials and channel drifts—which have so far yielded the great bulk of the tin supply—especially since the inception of dredging and hydraulic sluicing on a large scale.

Many old leads and drainage channels have furnished fossicking, and occasional rich patches, for small parties or individual miners, ever since the rich, virgin deposits were mined from them; but, after the modern system of dredging or hydraulic sluicing, under powerful steam pressure heads, has worked the whole contents of overburden and drift through the boxes, there is little hope of any further exploitation of importance, at all events, until sufficient time has elapsed to allow of natural sluicing and reconcentration of the tin lost in the tailings into reasonable compass—and this within the stream channels only.

The yield from dredging ground being so small—from ½ to 2 or 3 lb. of tin ore per cubic yard—and the average loss proportionately slight, removes the possibility of redredging in the near future, though individual effort might be directed to untested patches, and subsequent stream channels through the dredge tailings.

Most tin-leads of shallow depth have been worked and reworked, first by Europeans, then by the patient Chinese, finally by dredging where conditions were favourable.

Notwithstanding the re-working mentioned, the shallow leads still continue to yield small returns to occasional fossickers. The question now arises whether the channels of streams like Vegetable Creek, and Cope's Creek, and their tributaries, will afford employment after the dredges have ceased work.

However slight be the loss from the latter—particularly where dealing with free, granular, non-clayey drifts, there is already evidence that, in process of time, the tailings discharged into the channels from the dredges, will furnish a livelihood for fossickers, as subsequent floodings cut through the accumulations, and form definite waterways or natural sluices, into which the remaining tin ore will tend to concentrate.

Even during dredging operations in Cope's Creek, odd parties were treating material from the dredges by the aid of Californian pumps, worked by hand or horse-power.

* The Solomon Islands, Their Geology, &c., 1887, pp. 9 and 11.

The extent of the dredging loss can only be very approximately inferred, for it varies according to the rate of working, the nature of the ground, and the condition of the water supply. Where the latter is inadequate, and the overburden clayey, constant re-use aggravates the loss in the slimes.

Where it is advantageous to deal with large quantities rapidly, it is more economical to lose a small proportion than attempt to save it at increased cost and lessened output. Theoretically, clean extraction indicates good work; but the term is merely relative when commercially considered.

The basalt-covered "deep leads" of the principal tin-fields become more prominent as the shallow leads become depleted of their tin contents.

In the Emmaville district the position is little changed since Professor David estimated that out of a total length of 49½ miles of "deep lead" country only 2½ miles had been worked.* It must, however, be borne in mind that the worked areas of these leads were nearest the source of tin supply, and therefore the richest as well as the most accessible. The greater width and thickness of the basalt cover down these old valleys entails costly prospecting in locating the ancient stream beds or leads, where Nature has not intervened with later dissecting channels.

The pond-like, or detached, occurrence of the tin-bearing drifts within the deep-lead channels also entails considerable cost in the intermediate blanks. So that extensive capital is necessary for locating and for prospecting well ahead of actual stoping. Fortunately the increased value of tin of late years to some extent makes up for increased costs and lessened yields.

Lode-tin Mining.—A review of lode-tin mining in New South Wales, extending over the thirty-seven years since tin-mining began, instils a feeling of disappointment, if not pessimism. Amid the almost innumerable lodes discovered in the New England Tin-fields the most regrettable feature is the rarity of large workable deposits, even of low grade. With a few notable exceptions, such as the Ottery, Butler, Dutchman, &c., few lodes have yet been discovered that offer inducement for adequate capital outlay. The vast majority are too small in size, and the tin-ore too capricious in occurrence to justify expenditure of capital. Occasionally some afford rich, but limited, bunches of almost pure tin-oxide, or equally rich thin veins. While the bunch, or pipe, continues, or the rich thin vein persists in soft decomposed rock, they afford profitable returns to small parties or individual miners, in spite of limited dimensions or thickness, but soon become unremunerative in hard unaltered granite or wet ground. Usually, however, these are only worked to shallow depths, and the ore crushed and concentrated by hand wtih pulling hammer and sieve, frequently after roasting, the bucking-table often being a flat rock outcrop.

The rarity of steam reduction plants in the past is significant of the precarious nature of lode-tin mining in the State, though in some instances at least lack of confidence and foresight were accountable. The well-known mode of occurrence of tin-shoots as lens-shaped bodies should have prompted adequate proving ahead of stoping, as well as reasonable confidence in recurrence beyond the blanks.

It is certain that the principal lodes offer inducement for further development, and that numerous smaller lodes will continue to yield employment to small parties and individual miners. (See also pages 33–36.)

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* Geol. Veg. Ck., 1887, p. 12.

XII.—STATISTICS.

ESTIMATED Tonnage Yields from the principal Tinfields (in Divisions), 1875 to 1910 inclusive, as far as ascertainable.

Year.	Division.			
	Glen Innes.	Emmaville.	Wilson's Downfall, Tenterfield.	Tingha.
1875	.....	3,040	1,560	1,674
1876	1,000	3,008½	1,386	2,300
1877	100	1,749	1,395	1,800
1878	300	1,936	1,107	1,500
1879	300	2,715¼	709	1,035
1880	263¾	3,696¼	677	1,722
1881	500	4,039½	545	2,500
1882	353	3,157	615	3,110½
1883	302	2,509	450	3,636
1884	132	2,241	490	2,392
1885	160	2,505¼	311	1,834
1886	91	1,894	307	1,649
1887	171	2,639½	270	1,260
1888	196¼	1,037½	203	1,007
1889	143	1,553	254	1,352
1890	151	1,150	220	1,000
1891	43	973	240	600
1892	163	1,063	244	500
1893	80¼	1,035	176½	700
1894	84	1,108½	156¾	742
1895	165	900	98	139
1896	175	723	150	628
1897	66	600	80	690
1898	.....	473	65	540
1899	89½	696	2	470
900	70	438¼	79	500
1901	5¼	307	75	402
1902	4¼	466	43	400
1903	9	450	49¾	465
1904	15	500	180	550
1905	10	453	104	1,157
1906	100	410	121	1,481
1907	145	413	170	1,812
1908	63¾	547½	234	1,407
1909	24	675	229	1,495
1910	70	788	195	1,057
Total	5,545	51,890	13,191	45,506½

The following Table, prepared from the Annual Reports of the Department of Mines, shows the estimated production and value of tin since the opening of the New South Wales Tin-fields in 1872 to the end of 1910 :—

Year.	Ingots.			Ore.			Total Value
	Quantity.	Value.	Average per ton.	Quantity.	Value.	Average per ton.	
	tons cwt.	£	£	tons cwt.	£	£	£
1872							12,227
1873	5,443 11	523,880	96·2	8,649 5	472,286	54·3	249,887
1874							372,777
1875							361,275
1876	3,465 0	239,100	69·0	1,509 5	60,340	39·9	299,440
1877	3,279 8	218,348	66·6	823 15	30,558	37·1	248,906
1878	2,894 15	179,528	62·0	1,169 0	35,085	30·0	214,613
1879	3,281 5	225,908	68·8	844 6	30,374	36·0	256,282
1880	3,910 19	323,425	82·7	684 12	30,827	45·0	354,252
1881	5,824 1	531,303	91·2	609 6	37,492	61·5	568,795
1882	5,101 2	508,523	99·7	610 19	32,890	53·8	541,413
1883	4,643 12	427,202	92·0	445 4	21,685	48·7	448,887
1884	3,362 0	266,325	79·2	349 13	14,861	42·5	281,186
1885	3,338 8	283,592	84·9	534 18	25,168	47·0	308,760
1886	2,664 18	259,195	97·3	326 18	18,350	56·1	277,545
1887	2,625 6	295,478	112·5	291 13	16,411	56·3	311,889
1888	2,260 13	296,196	131·0	247 8	13,314	53·8	309,510
1889	2,084 10	195,865	94·0	234 7	11,805	50·4	207,670
1890	1,725 18	166,333	96·4	259 4	12,724	49·1	179,057
1891	1,454 2	124,320	85·5	203 5	9,643	47·4	133,963
1892	1,485 2	140,421	94·5	239 2	12,573	52·6	152,994
1893	1,393 2	119,510	85·8	148 1	6,604	44·6	126,114
1894	1,137 17	77,512	68·1	190 7	7,752	40·7	85,264
1895	1,325 3	85,394	64·4	77 4	2,543	32·9	87,937
1896	1,128 18	65,641	58·1	96 19	2,905	30·0	68,546
1897	786 9	49,340	62·7	14 2	560	39·7	49,900
1898	628 15	45,603	72·5	1 4	35	29·2	45,638
1899	739 4	90,037	121·8	7 6	445	61·0	90,482
1900	1,070 9	141,824	132·5	15 2	900	59·6	142,724
1901	648 10	76,080	117·3	10 17	464	42·8	76,544
1902	493 15	58,521	118·5	22 19	1,072	46·7	59,593
1903	933 10	120,778	129·4	546 14	29,430	53·8	150,208
1904	1,073 14	138,881	129·3	626 4	49,496	79·0	183,377
1905	1,170 2	163,595	139·8	786 9	62,515	79·5	226,110
1906	1,161 0	205,373	176·9	510 0	50,371	98·8	255,744
1907	1,331 0	229,607	172·5	583 0	63,698	109·2	293,305
1908	954 0	126,292	132·4	841 0	79,155	94·1	205,447
1909	951 0	127,089	133·6	992 0	83,940	84·6	211,029
1910	847 0	127,700	150·7	1,021 0	100,456	98·3	228,156
Total.....	76,617 18	7,253,719	94·6	24,522 8	1,428,727	58·2	8,682,446

The estimated yield from tin dredging during the eleven years 1900 to 1910 amounts to 8,824 tons, valued at £841,160 (Ann. Rept. Dept. Mines N. S. Wales for 1910).

TABLE showing number of persons and value of machinery employed in the Tin-mining Industry, from 1900 to 1910. Compiled from the Annual Reports of the Department of Mines, New South Wales.

Year.	Persons employed.		Total.	Value of Machinery employed.
	Europeans.	Chinese.		
				£
1900	1,050	363	1,413	24,218
1901	972	456	1,428	27,343
1902	986	302	1,288	55,681
1903	2,047	455	2,502	51,866
1904	2,150	595	2,745	46,793
1905	2,212	672	2,884	65,358
1906	3,157	638	3,795	118,672
1907	2,739	434	3,173	157,352
1908	2,076	380	2,456	175,731
1909	1,688	349	2,037	164,032
1910	1,868	160	2,028	185,916

The approximate value of tin produced in the various States of the Commonwealth to the end of 1909 and 1910, as far as available, is as follows :—

	To end of 1909.		To end of 1910.
Tasmania	£9,428,926*	.....	£10,883,242*
New South Wales	8,454,290†	.....	8,682,446†
Queensland	7,195,083‡	.....	7,434,391‡
Western Australia	879,138§	.....	913,602¶
Victoria	769,824‖		
	£26,727,261		£27,913,681

The following comparative statistics are extracted from the 16th Annual Issue (1900–1909), compiled by the Metallgesellschaft, the Metallurgische Gesellschaft A–G, and the Berg-und Metallbank, Aktiengesellschaft, Frankfort on the Main, June, 1910, p. XXIV. :—

Tin.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
World's production—Metric tons.	80,300	89,200	91,300	93,600	98,800	96,600	98,800	97,700	107,500
Yearly average price	£ s. d. 133 11 6	£ s. d. 118 12 8	£ s. d. 120 14 5	£ s. d. 127 6 5	£ s. d. 126 14 8	£ s. d. 143 1 8	£ s. d. 180 12 11	£ s. d. 172 12 9	£ s. d. 133 2 6

* Report Sec. for Mines Tas. 1894, 1909, and 1910.
† Ann. Rept. Dept. Mines N. S. Wales for 1909, p. 51, and Q'sland Govt. Mining Journs. for 1910.
‡ Ann. Rept. Dept. Mines, Queensland, 1909, p. 22.
§ A. Gibb Maitland, Govt. Geologist, Australian Mining and Engineering Review, III, No. 26 Nov., 1909, pp. 75, 76.
‖ Ann. Rept. Dept. Mines, Victoria, 1909, p. 25.
¶ To 30th Nov., 1910, only.

"The World's production of tin, which—after remaining stationary for five years—rose 10,000 tons in 1908 to 107,500 tons, the largest increase it had experienced for many years, advanced last year only 800 tons, bringing the total up to 108,300 tons. This increase—though in itself unimportant—is, nevertheless remarkable, seeing that the Straits shipments fell off to the extent of 2,200 tons, *i.e.*, from 63,700 tons to 61,500 tons. The lower shipments in question were, however, more than counterbalanced by Germany's increase in production from 6,400 tons to 9,000 tons, an advance of 2,600 tons, or about 40 per cent. Germany's output of tin, as we have pointed out in previous years, is produced almost exclusively from Bolivian ores, and the bulk of England's production also comes from ores of this origin. The development of Bolivia as a producer of tin ore (metallic tin is not produced there) is illustrated by the following figures taken from the Mining Journal of 19th March, 1910. According to that Journal, the the production, practically the whole of which was exported, was as follows :—

1904.....20,700 tons.	1907.....27,700 tons.
1905.....27,700 ,,	1908.....29,900 ,,
1906.....29,400 ,,	1909.....35,600 ,,

Monthly Average Prices for Foreign Tin on the London Metal Exchange (in £ per English ton)* :—

	1905.	1906.	1907.	1908.	1909.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ . d.
January	131 5 11	164 11 10	190 4 0	123 9 0	127 7 3
February	131 3 6	166 0 10	191 18 9	128 14 1	127 15 8
March	134 17 2	166 1 2	188 17 6	137 19 8	130 6 7
April	140 11 8	176 14 5	187 1 2	143 12 10	133 8 3
May	136 11 8	192 6 4	191 1 10	135 11 6	131 16 10
June	138 3 6	178 0 7	187 10 11	127 12 2	133 4 0
July	144 6 8	170 12 5	188 0 2	131 6 10	131 19 0
August	150 5 6	180 19 11	170 5 9	134 16 2	135 18 3
September	146 11 9	184 15 3	166 6 6	131 6 8	137 14 6
October	148 3 6	195 15 11	146 7 7	133 8 8	138 13 2
November	152 5 3	195 15 10	138 8 8	137 8 3	140 0 3
December	162 14 3	195 19 9	125 10 4	132 4 7	149 2 3
Yearly average..£	143 1 8	180 12 11	172 12 9	133 2 6	134 15 6

* *Op. cit.*, p. XXV.

"The average prices for the first four months of 1910 were as follows:—

	£	s.	d.
January	148	3	6
February	149	13	0
March	147	4	11
April	149	19	3

Comparative Statement of the Production of Raw Tin.

Producing Country.	Raw Tin in Metric Tons.								
	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
Straits Shipments total†	48,630	53,842	54,571	56,223	61,838	59,500	59,375	56,550	63,690
England—									
(*a*) Production from native ores.	4,336	4,673	5,462	4,349	4,198	4,533	4,594	4,478	5,127
(*b*) Production from foreign ores.‡	3,575	5,675	6,050	6,400	7,450	8,500	9,350	10,020	11,614
Banka—Sales in Holland.	12,000	15,240	15,240	15,340	11,735	10,260	9,450	11,440	11,710
Germany ‡	2,031	1,451	3,000	5,060	5,000	5,233	6,596	5,838	6,375
Australia	3,800	3.900	4,100	5,500	5,300	5,800	7,400	7,100	6,700
Billiton—Sales in Holland and Java.	5,913	4,457	3,958	3,708	3,251	2,760	1,980	2,260	2,270
Production of raw tin, total about.	80,300	89,200	91,300	96,500	93 300	96,600	98,800	97,700	107,500
Yearly average price of raw tin.	£ s. d. 133 11 6	£ s. d. 118 12 8	£ s. d. 120 14 5	£ s. d. 127 6 5	£ s. d. 126 14 8	£ s. d. 143 1 8	£ s. d. 180 12 11	£ s. d. 172 12 9	£ s. d. 133 2 6

* *Op. cit.*, p. 14.

† The Straits shipments tin is distributed between Europe and America on the one hand and Eastern A other, as follows:—

Straits Shipments.	Raw Tin in Metric Tons.								
	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.
To Europe and America	46,805	51,145	52,660	53,050	58,488	57,750	58,055	53,360	61,460
To British India and China	1,825	2,697	1,911	3,173	3,350	1,750	1,320	3,190	2,230

‡ The English production from foreign ores, as also the German production, is mainly derived from Bolivian o

N.B.—The following outputs have not been accounted for in the abov table for the want of reliable information:—

(*a*) The unimportant production of European countries from native ores England excepted.

(*b*) The exports from Siam and the Dutch East Indies to British India, China, Korea, and Japan.

(c) The home consumption of the Straits Settlements, Siam, and the Dutch East Indies.

(*d*) The production of China.

PARATIVE View of the Highest and Lowest Prices of Tin from 1864 to 1909 inclusive.

(From charts compiled by Messrs. Vivian, Younger, and Bond, London.)*

	1864.		1865.		1866.		1867.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d	£ s. d.	£ s. d.	£ s. d.	£ s. d.
s Tin	120 0 0	87 0 0	96 10 0	85 10 0.	94 0 0	75 0 0	90 10 0	81 10 0
	1868.		1869.		1870.		1871.	
	108 0 0	87 0 0	136 0 0	109 0 0	134 10 0	104 10 0	155 10 0	124 0 0
Tin (from 1873 on)	1872.		1873.		1874.		1875.	
	159 0 0	130 0 0	149 0 0	114 10 0	121 10 0	87 0 0	96 10 0	76 0 0
	1876.		1877.		1878.		1879.	
	81 0 0	70 0 0	76 0 0	64 10 0	65 10 0	52 10 0	96 0 0	59 0 0
	1880.		1881.		1882.		1883.	
	102 0 0	68 10 0	110 10 0	85 10 0	114 10 0	86 10 0	98 10 0	82 10 0
	1884.		1885.		1886.		1887.	
	87 10 0	72 10 0	97 0 0	74 0 0	103 5 0	91 10 0	167 0 0	99 15 0
	1888.		1889.		1890.		1891.	
	170 0 0	75 0 0	99 5 0	87 15 0	104 5 0	88 7 6	94 7 6	89 2 6
	1892.		1893.		1894.		1895.	
	103 5 0	88 15 0	95 10 0	74 0 0	74 0 0	60 17 6	69 0 0	58 15 0
	1896.		1897.		1898.		1899.	
	61 15 0	56 0 0	63 11 3	58 10 0	86 5 0	62 15 0	151 0 0	87 0 0
	1900.		1901.		1902.		1903.	
	153 0 0	103 5 0	140 0 0	97 10 0	137 5 0	98 0 0	141 10 0	111 10 0
	1904.		1905.		1906.		1907.	
	137 0 0	115 15 0	166 5 0	129 5 0	215 0 0	161 0 1	200 0 0	115 0 0
	1908.		1909.		1910.†			
	147 0 0	118 0 0	156 0 0	123 10 0	176 15 0	143 7 6	.....	

* *Op. cit*, p. 111. † Advance figures.

Appendix A.

Sturtridge and Schumacker's Dredge, in M.Ls. 25–27, 36, Parish Scone, County Gough; own as the "East Britain Sluicing Claim," on the extreme head of Vegetable Creek.

Operations started in July, 1909, with a 30 h.p. semi-portable boiler, 8 h.p. portable ine, 8-inch Morris gravel pump, and 6-inch nozzle pump, &c.

Owing to limited catchment, operations were mainly directed to excavation for water rage, the tailings being utilised for dams and embankments. The tin recovered to the end December, 1909, amounted to about 5 or 6 tons. Owing to diminished water supply, and bidity from frequent usage, the plant had to be closed down.

More powerful machinery was procured, consisting of two 16 h.p. compound Garrett table engines, Wilberforce gravel and 8-inch nozzle pumps. The whole being installed at a v site.

The water supply having been replenished in June, 1910, sluicing was resumed, and tinued with varying success to the end of that year, when the water difficulty again arose, using suspension.

The average depth of sluicing ground is about 10 feet, much of it having been worked in early days of mining. Where unworked it is clayey and cemented in part, requiring losives to assist the nozzle stream in breaking down. The yield, so far as sluicing proceeded, has equalled about 2 lb. per cubic yard. The chief difficulty, as indicated ove, being the limited water supply.

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